THE
HOME TEACHER

A CYCLOPÆDIA OF
SELF-INSTRUCTION

EDITED BY

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ENGLISH LITERATURE.—CHAPTER XIII.

THE SINGERS OF THE SEVENTEENTH CENTURY, CAVALIERS AND ROUNDHEADS: MILTON TO DRYDEN.

Edmund Spenser had not yet lain ten years at rest in Westminster Abbey, and William Shakespeare had not finally retired from Blackfriars Parish, London, to Stratford-upon-Avon, when John Milton was born, on Friday, 9th December, 1608, in Bread Street, London. His father was a scrivener or attorney, whose wife, a Caston or a Bradshaw, was "a most excellent mother, and particularly known for her charities in the neighbourhood." The poet was baptized—probably by the Rev. Richard Stocke, then minister of the parish—in Allhallows Church, Bread Street, on the 20th—his father having grieved his family by adopting the reformed doctrines, and been cast off on that account. Under the sign of the "Spread Eagle" Milton's boyhood passed, and as in Bread Street the Mermaid Tavern stood, might not John Milton, scrivener, a man of musical ability and literary taste, have had the commerce of courtesy with Jonson, Beaumont and Fletcher, Shakespeare, and other poets who frequented that notable hostel? and might not this boy of unusual promise have looked with his clear dark-gray eyes upon these great and famous men? The lovable seriousness of the little lad led to his being destined to scholarship and the church. Hence he was placed under sundry masters and teachers, both at home and at the schools. One of these, the Rev. Thomas Young of Luncarty, a student of St. Andrews, when acting as his private tutor, awoke in him the love of poetry, and led him to practise the arts of verse. He was sent to St. Paul's School, in St. Paul's Churchyard, about 1620. His teachers were the Rev. Alexander Gill, master, and his similarly named son, usher. They were both men of considerable repute; the former, "a noted Latinist, critic, and divine," had "an excellent way of training up youth," and the latter, a splendid maker of Latin and Greek verses, won the strongest esteem and affection of his pupil, and for a time aided him with advice and criticism.

Milton began his university life at Christ's College, Cambridge, 12th February, 1624-25, and left it early in 1632, shortly after having written his noble Petrarchian sonnet:—

"How soon hath time, the subtle thief of youth,
Stol'n on his wing my three-and-twentieth year!
My hasting days fly on with full career,
But my late spring no bud or blossom show'th.

"Perhaps my semblance might deceive the truth
That I to manhood am arrived so near;
And inward ripeness doth much less appear,
That some more truly-happy spirits endu'th.

"Yet be it less, or more, or soon, or slow,
It shall be still in strictest measure even
To that same lot, however mean or high,
Toward which Time leads me and the will of Heaven;
All is, if I have grace to use it so,
As ever in my great Taskmaster's eye."

Milton's translations of Psalms cxiv. and cxxxvi. belong to his fifteenth year—and he had written verses before that. His "Ode on the Death of a Fair Infant"—the first-born daughter of his sister Anne [Philips]—is dated two years later, and for Christmas, 1629, he produced one of the most beautiful odes in the English language. "On the Morning of Christ's Nativity" is at once varied in matter, musical in measure, and grand in thought. The lyrical stanza chosen is fresh, vigorous, and fervid. In it human adoration is spiritualized into a fine incense, sending forth in glory to the sky its fragrant golden flame. About this time, too, he wrote many elegies, poems, &c., which have placed him among the best of modern composers of Latin verse. In some way he had been led to withdraw from preparation for the church; he was even more averse to the law, and when, in 1632, he returned to the parental roof at Horton, in Buckinghamshire, he continued his studies of the Greek and Roman classics, especially in history and philosophy. His fondness for Spenser and Shak[illegible]d no diminution, although he made himself admiringly and exactly acquainted with Italian poetry. While here, Milton wrote three songs and a soliloquy in recitative prose for the masque "Arcades," to be performed at Harefield, the seat of the Countess-Dowager of Derby—that Lady Alice to whom Spenser had dedicated his "Tears of the Muses" (1591). "Comus," a most exquisite masque, not only in poetic form, but also in intrinsic essence, recalling at once the "Philoctetes" of Sophocles, "As You Like It," by Shakespeare, and Fletcher's "Faithful Shepherdess," was written for her son-in-law, John Egerton, lord-president of Wales, first earl of Bridgewater. It was performed before that nobleman in the semi-regal residence of Ludlow Castle. We have in this masterpiece of intellect and heart not only good words, pleasing thoughts, and harmonious verse, but the embodied spirit of human virtue. To this period also belong that precious pair of poetic pictures, "L'Allegro" and "Il Penseroso," in which the jocund innocence of true mirth and the pleasing fascinations of sagacious thoughtfulness are contrasted and compared, and shown to be not incompatible but necessary counterparts of one another.

Shortly after his mother's death, Milton was furnished by his father with the means of visiting Italy. At Florence, Rome, and Naples, he was welcomed. He took letters with him from Sir Henry Wotton to Lord Scudamore, the British ambassador at Paris, who introduced him to Hugo Grotius, then representative at the French court of Christina of Sweden. He visited Galileo, held intercourse with many learned and ingenious men, gained the friendship of the Marquis, John Baptista Manso, who had been one of Tasso's intimate friends. He was about to pass over into Sicily and Greece, when hearing of the civil commotions in England, he changed his purpose and returned. Here his preparation for a high poetic career was stayed, and he devoted to patriotism the zeal he had hitherto given to personal culture.

While Milton "calmly awaited the issue of the contest" between King and Commons, he undertook the education of a few youths; his views—averse from his college days to Episcopacy—drew him to the Independents, and in politics he became a republican. For the twenty years of the Civil War, the Commonwealth, and the Protectorate, his harp was left almost untouched, and he entered upon that course as a controversialist which made him so great in the polemics of politics, and so famous as one of the most ornate of the writers of Old English prose.

Milton married Mary Powell, daughter of a cavalier Oxfordshire gentleman, at Whitsuntide, 1643. She left him a few weeks afterwards, but subsequently begged pardon, and returned. Afterwards Mr. Powell and his wife being in distress, were received into Milton's house, where the former died 1647, the latter raised a lawsuit against her son-in-law, 1651, and Milton's wife died leaving him three daughters, 1653. He remarried in 1656. His second wife, Catharine Woodcock, died in February, 1657, and to her memory he dedicated one of his finest sonnets. His third wife, Elizabeth Minshul, whom he married in 1664, survived him.

On 15th March, 1648-49, Milton was appointed Secretary for Foreign Tongues to the Council of State of the Commonwealth. He was active and useful in this office till, in 1652, his eyesight entirely failed. Even after that he, with the help of Andrew Marvell, fulfilled his duties, and drew up Cromwell's manifesto in justification of the war with Spain, and his remonstrance against the massacre of the Vaudois—an incident which drew forth Milton's splendid invocatory sonnet, "Avenge, O Lord, Thy slaughtered saints," &c. After Cromwell's death and the Restoration (1660) Milton was consigned to obscurity of life. It was then, when all life seemed to have become as dry as desert dust, when he was

"In darkness and with dangers compassed round,"

that his thoughts reverted to the sainted song, bright with the bliss of holiness, full of the music of angel voices, glowing with the splendour of the skies, he had formerly longed to sing. Then, in ideal light, invisible worlds, in all the beauty and grandeur of their celestial scenery, broke upon his vision, the scripture story shone in the enrapturing glory of an inspired imagination, and, in the calm and lofty confidence of an intellect capable of coping with a divine theme, he devoted his rich memory, cultured mind, collected powers, and

mighty genius to "assert eternal providence and justify the ways of God to man." It is as a great argument, a thought-thrilling Theodicy, the "Paradise Lost" is presented to us; and only when taken as such can it be thoroughly appreciated. The argumentative sublimity of the Miltonic rhythmic ratiocination has been greatly lost sight of, and men, in their admiration of the ethereal spirit which informs it, have forgotten (and now disregard) the faith-prompted polemic it was intended to be. The details are so superbly chosen and so deftly managed; the fable is so nobly framed and so admirably sustained; the sentiments are so grand and exquisite; the language is so lucid, so select, and so wisely adapted to its purpose, that—stricken with these, comparatively speaking, mere adornments—men have left unmarked the majestic magnificence of the transcendent choral harmony in its entirety. Wisdom, righteousness, truth, and genius are matchlessly intertwined in this solemn song. "Paradise Regained" is an appendix, replete with the same power, but less thoroughly perfected—a sort of confirmatory postscript to the divinest poem mortal ever penned.

Poetry in the times of Charles II. had become leprosied. Neither "Abana nor Pharphar, rivers of Damascus," could cleanse the defilement of it—reaching even to the life-blood. Milton baptized it in the waters of Jordan, embued and renewed it with the life of Christ; as Collins sings—

> "Such bliss to one alone
> Of all the sons of Soul was known."

"Samson Agonistes" [*i.e.* the Struggler] is composed in the style of the Greek tragedy, and is incomparably the best reproduction we have, in English, of the form of that simple antique sort of drama. The theme was congenial to the author's experience, who could feelingly ejaculate with his hero,

> "O dark, dark, dark, amid the blaze of noon."

Milton died, in Sabbath quiet, at his house in Bunhill Fields, 8th November, 1674, and was buried in the Church of St. Giles, Cripplegate, London.

Francis Quarles, son of James Quarles, clerk of the Green Cloth under Queen Elizabeth, and Joan Dalton, was born in the family manor-house of Stewards, Rumford, Essex, May, 1592. His father died 25th September, 1599, leaving him an annuity of £50 per annum. His mother died in 1606, while he was at Christ's College, Cambridge, whence he removed to Lincoln's Inn. Subsequently to this he held the office of cup-bearer to the Queen of Bohemia, whom he accompanied to the Continent. On 26th May, 1618, he married Ursula Woodgate at St. Andrew's, Holborn, London. His "Feast for Worms, set forth in a poem of the History of Jonah," appeared in 1620, and was reissued 1626. "Job Militant," in part paraphrased, in part abridged from scripture, belongs to 1624, as do also "Sion's Elegies" or the Lamentations of Jeremiah, translated (and amplified) in verse. "Sion's Sonnets," the Song of Songs similarly treated, 1625. As secretary to Archbishop Ussher he was in Dublin in 1628, where he wrote his "Argalus and Parthenia," "a scion taken out of the orchard of Sir Philip Sidney of precious memory, and reproduced as a poetical pastoral romance." His "Historie of Samson," a striking series of thirty-three poetic meditations on the strong man of Zorah, with a good deal of plain speaking in them, written "to bees, not to spiders," bears date 1631. "The Emblems," those silent parables addressed to the eye, which he interpreted into such words as made him the darling of plebeian judgments, and enriched the associations of men's minds with many moral maxims metrically expressed, came out in 1635, and were reissued in 1639, with an appendix entitled "Hieroglyphicks of the Life of Man"—an Egyptian dish dressed in the English fashion. In the last-mentioned year Quarles was appointed chronologer to the city of London. Although engaged in the preparation of pageants and speeches for the city feasts, he continued active in authorship. Besides composing several poems on family bereavements, he published in 1640 his "Enchyridion" [*i.e.* Handbook], containing Institutions, Divine and Moral, reissued and enlarged in 1641, intended for the edification of Prince Charles. It is a collection of 400 happy thoughts, guesses at truth, glimpses of careful reflection, and gems of good sense, exceedingly suggestive and condensed; for example,

> "Be very circumspect in the choice of thy company: in the society of thine equals thou shalt enjoy more pleasure: in the society of thy superiors thou shalt find more profit. To be the best in the company is the way to grow worse. The best means to grow better is to be the worst there."

Several Royalist prose works subsequently proceeded from Quarles' pen. These excited reprisals. A petition was presented against him; his books and MSS. were "plundered;" he fell sick and died 8th September, 1644. Five years after his death R. Royston published Quarles' only comedy, "The Virgin Widow," which as a thing of "wit, worth, and well-seasoned mirth," had "been sometimes at Chelsea privately acted by a company of young gentlemen with good approvement." The general character and tenor of Quarles' poetry may be exemplified by the following extract:—

> "Why, what are men? but quickened lumps of earth;
> A feast for worms, a bubble full of mirth;
> A looking-glass for grief; a flash; a minute;
> A painted tomb, with putrefaction in it;
> A map of death; a burden of a song;
> A winter's dust; a worm of five feet long;
> Begot in sin, in darkness nourished, born
> In sorrow, naked, shiftless, and forlorn.
> His first voice heard is crying for relief;
> Alas! he comes into a world of grief:
> His age is sinful and his youth is vain;
> His life's a punishment, his death's a pain;
> His life's an hour of joy, a world of sorrow;
> His death's a winter night that finds no morrow.
> Man's life's an hour-glass, which being run,
> Concludes that hour of joy, and it is done."

Sir William Davenant was born at the Crowne Tavern, Oxford, February, 1605-6. His father was "grave and discreet," his mother handsome and witty. Shakespeare used to frequent the Crowne, "where he was exceedingly respected," on his way to and from Stratford, and on 3rd March the poet became sponsor for the boy. This occasioned the revival of an old joke about a godson, that in this case the name of God was taken in vain. There is no real ground for looking on this otherwise than as a jest. The boy loved Shakespeare, and was certainly influenced by him in his love of poetry. He was educated under Edward Sylvester and studied at Lincoln College, having Daniel Hough as his tutor. After the death of his mother, and, a fortnight thereafter, of his father (during his year of mayoralty), October, 1622, William was taken as page by Frances, first duchess of Richmond. He subsequently entered the service of Fulke Greville, lord Brooke (see page 674), and won the friendship of Endymion Porter and the Earl of St. Albans, to whom he dedicated his poem on "Madagascar" (1638). By turns he was dramatist, theatrical manager, soldier, projector, envoy, wit, and poet. While residing at the Louvre, in Paris, he composed a portion of "Gondibert, an Heroic Poem," which in a lengthy epistle he dedicated to Thomas Hobbes. It was satirically treated in "Certain Verses" (1653), by Denham, Donne, Sir Allen Broderick, and others, and against this he issued a "Vindication" in 1665. From Paris he collected a body of colonists bound for Virginia. The Parliamentarians intercepted this expedition, and he was first confined in Cowes Castle, and afterwards taken to the Tower. Here, while anticipating death, he continued "Gondibert," but by the intervention of Milton and two aldermen of York he was pardoned. When Milton was in a similar strait Davenant did a like service for him. After the Restoration Davenant devoted himself to the drama, received a royal patent from Charles II. for a theatre at Covent Garden, and acquired some reputation as a playwright. His first tragedy, "Albovine, King of Lombardy" (1629), was dedicated to the unfortunate Earl of Somerset. Fifteen dramas followed this, besides several masques and revivals of other plays. The works of Sir William Davenant, who died 7th April, 1668, were published in folio, 1673. In Dr. Langford's "Prison Books and their Authors" "Gondibert" finds no place; yet Davenant manfully says in a postscript—"It is high time to

strike sail and cast anchor (though I have run but half my course), when at the helm I am threatened with death—who, though he can visit us but once, seems troublesome, and even in the innocent may beget such gravity as diverts the music of verse." A half-finished Italian tale of 1500 four-lined stanzas is a goodly spell to give to the record of a faction-fight got up, through jealousy, by Prince Oswald of Verona against Duke Gondibert of Lombardy. Four combatants from each side are chosen to enter the lists. Gondibert, though severely wounded, slays Oswald, and the sage Astragon heals the Lombard hero, with whom Rhodalind, daughter and heir of Aribert, sovereign of Lombardy, is in love. Gondibert is, however, betrothed to Birtha, the pure-minded motherless daughter of Astragon. While he is walking with her a messenger arrives from the king requiring his instant coming to court—his majesty having publicly proclaimed the hero as his adopted successor and son-in-law. Gondibert pledges anew his faith to Birtha (whose character and love are delicately portrayed); and the story breaks off just as he places an emerald ring on her finger, which will only lose its lustre when he proves untrue—

"Had now an artful pencil Birtha drawn,
With grief all dark, then straight with joy all light,
He must have fancied first, in early dawn
A sudden break of beauty out of night."

Edmund Waller, born 1595, was lively in talk, felicitous in wit, but neither trusted nor trustworthy. He wrote many love-songs, delicate and tender, fanciful and elaborate, and in numerous verses in celebration of many public personages and events did much to improve the heroic couplet. He inherited, while young, a handsome estate, increased it by marriage with a wealthy lady, who died early, leaving him all her fortune. After this he pursued with affection the daughter of the Earl of Leicester, Lady Dorothea Sidney (whom he named, from the Greek *sachar*, sugar, *Saccharissa*). She married the Duke of Sunderland. A cousin of John Hampden's and related to Cromwell, he took at first the popular side. He was arrested in 1643 for participation in a plot to raise the Londoners in the king's behalf. Several of the complotters suffered the extreme penalty, but he, by submission, escaped. He sung with equal *nonchalance* and *abandon* panegyrics to Cromwell and to Charles. He sat repeatedly in Parliament, and died at Beaconsfield in 1687.

William Habington, born at Hendlip, Worcester, on Gunpowder Plot day, 5th November, 1605, was the son of Thomas Habington, who had been concerned in the Babington conspiracy and harboured some of Guy Fawkes' comrades. He was educated at St. Omer, but refused to join the Jesuits. He married Lucy Herbert, daughter of William, first Lord Powys, whom he celebrated as Castara [*i.e.* Lat. *casta ara*, a virgin shrine], and in whose praise he issued poems bearing that title (1635), and revised them 1640. He refrained from politics, but, at the request of Charles II., composed a "History of Edward IV." He was author of a tragi-comedy, "The Queen of Aragon," which Philip, earl of Pembroke, as lord chamberlain, commanded to be played at court and printed. It is a very excellent play. In it Sanmartino's dwarf, Browfildora, sings a smart satirical song, of which we quote the first two stanzas:—

"Fine young Folly, tho' you were
That fair beauty I did swear,
Yet you ne'er could reach my heart,
For we courtiers learn at school
Only with your sex to fool;
You're not worth the serious part.

"When I sigh and kiss your hand,
Cross my arms and wondering stand,
Holding parley with your eye,
Then dilate on my desires,
Swear the sun ne'er shot such fires—
All is but a handsome lie."

Samuel Butler, who wrote the prologue to Habington's play—a strong, middle-sized, choleric, sanguine man, having lion-brown hair—was born in Strensham, Worcester, February, 1612, educated with difficulty at Worcester Grammar School, was a lawyer's clerk and a gentleman-in-waiting on the Countess of Kent. He held some office in the household of Sir Samuel Luke, near Bedford, was, after the Restoration, secretary to Richard, earl of Carbury, lord president of Wales and steward of Ludlow Castle. He married a Mrs. Herbert, practised painting, and during his leisure wrote "Hudibras," a unique burlesque of upwards of 11,000 lines, which for droll rhymes, pungent wit, broad humour, queer casuistry, and quotable quaintnesses had no foregoer. It at once dazzles and delights, and is a sort of domestic Don Quixote, an epic in epigrams. Though never rich, Butler did not receive charity or die in want. His demise took place in Rose Street, off Covent Garden, London, 25th September, 1680. He left a large quantity of MS. in prose and verse, some of which were published under the title of "Remains" (1757). Here are a few of his clever couplets:—

On Oaths.

"He that imposes an oath makes it,
Not he that for convenience takes it;
Then how can any man be said
To break an oath he never made."

On keeping Faith with Heretics.

"All of us hold this for true,
No faith is to the wicked due;
For truth is precious and divine,
Too rich a pearl for carnal swine."

Sectarians.

"Compound for sins they are inclined to
By damning those they have no mind to,
Still so perverse and opposite,
As if they worshipped God in spite."

Honour.

"Honour's but a word
To swear by only, in a lord;
In other men 'tis but a huff
To vapour with—instead of proof;
That, like a wen, looks big and swells,
Is senseless, and is—nothing else."

Fame.

"There is a tall long-sided dame—
But wondrous light—yclepéd Fame,
That like a thin chameleon boards
Herself on air, and eats her words."

Very different from Butler was William Cartwright, son of an innkeeper in Northway, Gloucestershire, born 1611, educated at Westminster and Oxford. He became the most florid and seraphical preacher in the university, and was "the most noted poet, orator, and philosopher" of his time. "His body," says Gerard Langbaine, "was as handsome as his soul." Dr. Fell said of him, "Cartwright is the utmost man can come to," and Ben Jonson avers, "My son, Cartwright writes all like a man." He was one

"Whose learned fancy never was at rest,
But always labouring, yet laboured least."

More than fifty sets of eulogistic verses, by most of the wits of his time, preface his "Plays and Poems" (1651). His plays are "The Siege, or Love's Convert," "The Royal Slave" (in which Dr. Busby performed), "The Lady-Errant," tragicomedies, and "The Ordinary," a comedy. It is difficult to find in his works the fine spiritual intensity of thought which his portrait and the praises of his friends lead us to expect. He died of a camp fever at Oxford, 23rd December, 1643. He had written early in that year a sketch of the scanty fare during the siege, which he closes by saying—

"Troth I am like small birds, which now in spring,
When they have nought to eat, do sit and sing."

A much more merry-hearted Falstaffian sort of man was Dr. Richard Corbet, successively Bishop of Oxford and of Norwich. He was born at Ewell, in Surrey, in 1582, the son of a gardener who, Ben Jonson says, passed

"A life that knew nor noise nor strife,
But was by sweetening so his will
All order and disposure still."

He sent his son to Westminster, who thence proceeded to Oxford, where he took orders and attained great popularity as a preacher. He was chaplain to James I. Of a jovial, social, and convivial disposition, he was good-natured, forbearing, and rather light-minded. His poems, marked by pointed terseness, facetious mirth, and anti-Puritan feeling, were published posthumously in 1647, entitled "Poetica Stromata" [*i.e.* Poetic Patchwork]. He died 28th July, 1635. His "Iter Boreale—Northern Journey from Oxford to Newark" is recounted racily. His "Farewell to the Fairies," his "Journey to France," and his "Verses to his son Vincent" are embalmed in all selections of poetry.

John Cleveland, born at Loughborough, Leicestershire, in 1613, studied at Cambridge, was college tutor and reader in rhetoric. When the Civil War broke out he proved a brave soldier, and was a ready writer of lampoons on the Roundheads. He was imprisoned at Yarmouth, but Cromwell pityingly released him, and he reviled the Protector no more. Political personalities and wildly far-fetched conceits abound, but their temporary interest has almost passed away, and only a few love-songs of this boisterous roisterer have much life or attraction. He died 29th April, 1658. We quote these lines from "The King Beheaded"—

"The blow struck Britain blind, each well-set limb
By dislocation was lopped off in him,
And tho' she yet lives, she lives but to condole
Three bleeding bodies left without a soul;
Religion puts on black and loyally
Blushes, and mourns to see bright Majesty
Butchered by such assassinates; nay both
'Gainst God, 'gainst law, allegiance, and their oath."

One of the lightest liquor-loving lyrists was Robert Herrick, the songster of sensation, born in Cheapside, London, 1591, studied at Cambridge, and presented (1629) by Charles I. to the vicarage of Dean Prior, Devonshire, over

"A people currish, churlish as the seas,
And rude almost as rudest salvagés."

He was deprived by Cromwell, 1648, and reponed by Charles II., 1660. He was in holy orders, but holy orders had little charm for him. He sighed—even with his pet tame pig, his pipe, his pot, and Prue, his prudent maid, to see to his comfort—for the town and its tavern-joys. In dull Devonshire he flirted with the muses, and filled reams of foolscap with aspirations after amorous bliss. Now epicureanism takes hold of him, and he is coyly exquisite in his expressions of the fascinations of the world; again melancholy marks him for her own, and he does poetic penance in a mingled glad-sad melody. Here he speaks in serious mood—

"Look how the rainbow doth appear,
But in one only hemisphere;
So likewise after our decease,
No more is seen the arch of peace.
That covenant's here; the under-bow,
That nothing shoots but war and woe."

Hear him again when he is a little lighter-minded, though thinking "upon the troublesome times."

Oh! Times most bad,
Without the scope
Of hope,
Of better to be had!
Where shall I go,
Or whether run
To shun
This public overthrow?

"No places are—
This I am sure—
Secure,
In this our wasting war:
Some storms we've past,
Yet we must all
Down fall,
And perish at the last."

Thomas Carew, one of the Carews of Gloucestershire, was a singer of a similar sort. His verses have a soft seriousness and sentimentality of style; his love-poems are pellucid and gracefully gay. When serious he says good things, as—

"He that loves a rosy cheek,
Or a coral lip admires,
Or from starlike eyes doth seek
Fuel to maintain his fires:
As old Time makes these decay,
So his flames must waste away.

"But a smooth and steadfast mind,
Gentle thoughts and calm desires,
Hearts by equal love combined,
Kindle never-failing fires.
Where these are not, I despise
Lovely cheeks, or lips, or eyes."

Carew was born 1589, was Gentleman of the Privy Chamber to Charles I., and died 1639.

Sir John Suckling, son of the Controller of the Royal Household of James and Charles, was one of the sprightliest gallants of the court, and greatly given to gaming. He had the trick of word weaving, and did it skilfully with pretty patterns and bright colours. Everything he took in hand was dashingly done—scouring the Continent, fighting under Gustavus Adolphus, feasting his friends in London, raising a troop of horse for the king's service, spending £12,000 on its equipment, only to find it wheel about and flee before the Scots. He joined a plot to rescue Strafford, was summoned to appear before Parliament, fled to France, and there died in Paris, 7th May, 1641. His humour was delicious, his fancy gay, his badinage brisk, and his diction exquisite. Five plays, some speeches, letters, tracts, and poems form the contents of his "Fragmenta Aurea" (Golden Fragments, 1646). Here is one of his curious conceits—

"I pray thee send me back my heart,
Since I can not have thine,
For if from yours you will not part,
Why then should'st thou have mine?
Yet, now I think on't, let it lie,
To find it were in vain;
For thou'st a thief in either eye
Would steal it back again."

Among other minor writers may be named Richard Brathwaite (1588–1673), a freeholder of Kendal, educated at Oriel, Oxford, who wrote in many volumes sharply against Puritanism in prose and verse, but the instruction and delight they afford are like Gratiano's talk; Samuel Rowley, player and playwright, who was in the service of Prince Henry, of whose productions only "The Noble Soldier" and "When you see me you know me" survive; Alexander Brome (1620–66), a London attorney, who ridiculed the Roundheads trenchantly, is spoken highly of by Isaak Walton, as famous for his epistles, epigrams, translations, and his comedy of "The Cunning Lovers" (1654), as well as for his edition of the very excellent comedies of his namesake Richard Brome, Ben Jonson's servant and imitator; Barten Holyday (1593–1661), born in, and afterwards archdeacon of, Oxford, author of twenty (published) sermons, translations of Juvenal and Persius, a poem entitled "A Survey of the World," and the comedy of "Technogamia" [*i.e.* The Marriage of the Arts], regarding which this epigram survives:—

"At 'The Marriage of the Arts' before the king,
Lest those brave mates should want an offering,
The king himself did offer—What I pray?
He offered twice or thrice—to go away."

We may not forget Ben Jonson's "Chronomastix" [*i.e.* the satirist of his time], whose fame, despite the flatness and egotism of much of his verse, will not wholly fade—old George Wither, who in "honest, plain matter" showed the times' "Abuses, Stript and Whipt" (1613). A brave, sturdy, combative, John-Bullish sort of good fellow, who says,

"My mind's my kingdom, and I will permit
No other's will to have the rule of it;
For I am free, and no man's power, I know,
Did make me this, or shall unmake me now."

He flowered early, and, it must be confessed, ran a good deal to seed. He was born 11th June, 1588, and was the only son of George Wither of Bentworth, near Alton, Hampshire, and of his wife Anne Serle. He was educated at the Grammar School of Colemore, and, after three years' attendance at Magdalen College, Oxford, was called home (degreeless) "to hold the plough." He afterwards took to the study of the law, but his keen zest in rhyming took issue in those poetical "satirical essayes" on the manners of the time for which, in his twenty-fifth year, he made acquaintance for

some months with the interior of Marshalsea prison. From this he was released after the issue of his "Satire to the King" (1614). The mettle of his spirit, and his sufferings, made him a favourite with the Puritan party, and his "Abuses" were so popular that seven editions were required in twenty years. His earlier productions, the finely-touched "Shepherd's Hunting" (written in 1608) and the exceedingly varied and excellently-toned "Fair Virtue, or the Mistress of Philarete" (composed 1610), were published respectively in 1615 and 1622. He was profuse in pouring forth hasty and irregular, but wonderfully facile and fertile rhymes—as, "An Elegiacal Epistle of Fidelia" (a fragment of some greater poem, issued by subscription, to replenish his purse), 1615; "Wither's Motto" (1618)—*Nec habeo, nec careo, nec curo* (I neither have, want, nor care)—in which his theme is (1) what Wither is, (2) what he is not, and (3) what he cares not to have or be: the verse is at once scathing and excoriating; "Preparation to the Psalter" (1619), containing some noble and happy stanzas; "Britain's Remembrancer" (1628), eight cantos giving a record of the plague of 1625, which the author boasts he braved by staying in London. Wither went out as Captain of the Horse against the Scots in 1639. When the Civil War began he raised a troop of horse for the Parliament, and went into the field as major, bearing the motto, *Pro rege, lege, grege* (for king, law, and people). He was taken prisoner by the Royalists, but Denham, with unkind kindness, wittily begged him off, because "while Wither lived he (Denham) would not be the worst poet in England." Cromwell made him a justice of peace, major-general of the troops in Surrey, and master of the statute office. The Convention Parliament sent him to Newgate, and he was afterwards confined in the Tower, from which, however, he was set free some years before his death, which took place 2nd May, 1657. Wither's early idiomatic raciness, direct transparency, and easy vigour degenerated into slovenly simplicity and negligent facility; but in many of his rhymes there is a fresh sunniness, love of nature, and freeness of speech which attract, though one often feels disappointed at the absence of selective taste. He undoubtedly foreshadowed the descriptive poetry of the Carolan era. Here is a bit of melodious song:—

"Shall I, wasting in despair,
Die because a woman's fair?
Or make pale my cheeks with care,
'Cause another's rosy are?
Be she fairer than the day,
Or the flowery meads in May,
If she be not so to me,
What care I how fair she be?

"Great or good, or kind or fair,
I will ne'er the more despair;
If she love me, this believe,
I will die e'er she shall grieve;
If she scorn me when I woo,
I can scorn and let her go;
If she be not fit for me,
What care I for whom she be?"

A more singular figure among singers than even Wither was John Taylor, "the King's Majesty's Water-poet and the Queen's Water-man," born at Gloucester, 24th August, 1580, who "had he had learning bestowed on him according to his natural parts, which were excellent, might," as Anthony Wood says, "have equalled, if not excelled, many who claim a great share in the temple of the Muses." He came to London and earned his living by rowing a passage-boat on the Thames. He was a noted humorist and a merry wag, ready on the instant to compose ode, elegy, sonnet, anagram, epigram, or nipping satirical song on any reasonable terms. These he hawked about for sale, being his own author, publisher, and peripatetic bookseller for forty years, besides being a licensed victualler, a custom-house officer, an adventurer by sea and land, ready for any whim, practical or poetical, and sometimes both, as in the case of his burlesque of "Ben Jonson's Visit to Scotland," 14th July to 18th October, 1818, which he, though lame, did on foot and in verse. He was a firm Royalist, and did not care to conceal it. His house, called "The Poet's Head," was situated in Phœnix Alley, Long Acre. There he died, in 1653, on the 5th December of which year he was buried in St. Martin's-in-the-Fields, Westminster. In 1630 he bound up in a large folio all his prose and verse, and issued them as his works; and he left behind him, had they been all collected, as many as would have made another folio equally large. These his widow used to retail. He writes thus, in "The old, old, very old Man." a life of Thomas Parr (1635):—

"This Thomas Parr hath lived the expired reign
Of *ten* great kings and queens; the eleventh now sways
The sceptre (blest by The Ancient of all Days);
He hath survived the Edwards Fourth and Fifth,
And the Third Richard, who made many a shift
To place the crown on his ambitious head;
The Seventh and Eighth brave Henrys both are dead,
Sixth Edward, Mary and Philip, Elizabeth,
And blessed-remembered James—all these by death
Have changed life, and almost eleven years since
The happy reign of Charles, our gracious prince,
Tom Parr has lived, as by Record appears,
Nine months, one hundred, fifty and two years."

Abraham Cowley, the posthumous son of Thomas Cowley, stationer, in the parish of St. Michael-le-Quern, London, and his wife Thomasine, was born about the time that Sir Walter Raleigh was beheaded (October, 1618), when Milton was nearly ten years old, and he died 28th July, 1667, in the forty-ninth year of his age, just when "Paradise Lost" was issuing from the press. "Milton is said," as Dr. Johnson tells us, "to have declared that the three greatest English poets were Spenser, Shakespeare, and Cowley." As a boy he was fond of books, read Spenser all over before he was twelve years old, and was irremediably smitten with poetry. So early as his tenth year he had written verses on "Pyramus and Thisbe;" only a little later he composed "Constantia and Philetus;" and in 1633 "Poetical Blossoms," by A. C., were published while he was a pupil of Westminster. In 1636 a second edition of his early productions, with the addition of "Sylva," was published, and he was a candidate for Cambridge, but not elected. In that year, however, he proceeded to Trinity College. Next year a third edition of his boyish verses was published, and this was followed, in 1638, by the issue of "Love's Riddle, a Pastoral Comedie," written at the time of his being "King's Scholler in Westminster Schoole," and by that of "Naufragium Joculare" [*i.e.* the Merry Shipwreck], a Latin comedy which had been acted in Trinity, February, 1638. Of this, under the title "Fortune in Her Wits," an indifferent translation by Charles Johnson was published in 1705. He took both of his degrees in due course. In the interval between these two incidents he produced—when Prince Charles visited the university, March, 1641—"The Guardian," a comedy which he revised and reproduced in 1658 as "The Cutter of Coleman Street." In 1647 "The Mistresse," a collection of love verses, was published, though Dr. Joshua Barnes states that their author was never moved by love but once, and then could not muster courage to make known his passion.

Cowley was a Royalist, and suffered deprivation of his places on that account. He sought refuge for a while in St. John's College, Oxford; then becoming secretary to Lord Jermyn, afterwards Earl of St. Albans, he followed Henrietta Maria to Paris. He was sent in 1656 back to England, seized by mistake for somebody else, imprisoned, and only relieved on giving bail for £1000. On his release he received from Oxford the degree of M.D., 1657; under this influence he studied botany in Kent, and composed six books in very elegant Latin verse—(1) "On Plants," (2) "On Herbs," (3 and 4) "On Flowers," and (5 and 6) "On Trees." After the Restoration, though he had served the royal house so well, he was left without reward, and retired to Chertsey, in Surrey, where, through the kindly influence of friends, he acquired lands which would have afforded him about £300 per annum. There the last numbers flowed from Cowley's tongue, for almost immediately upon his arrival he was overtaken with a severe cold, which seems to have settled down upon him, and after a very short residence (of about two years) he died at the Porch House, Chertsey. He was buried near Chaucer and

Spenser in Westminster Abbey on 3rd August, 1667, many poets composing panegyrics on the "ingenious Cowley"—

"O'errun with wit and lavish of his thought."

Archbishop Trench very aptly describes his "Ode to the Royal Society," composed at the request of John Evelyn, as "the first book of 'The Novum Organum' transfigured into poetry." His forty-four love poems, "The Mistresse," are ingenious in conceit, not quickening to the heart—clever, sparkling, but like icicles—though bright yet cold; *e.g.*

"My love, a kind of dream, was grown,
A foolish but a pleasant one,
From which I've wakened now; but oh!
Prisoners to die are wakened so."

Here is the intensest of his fond fooleries of love-phrase—

"I'll kiss thee through; I'll kiss thy very soul."

The shapeless stanzas of his "Pindaric Odes" contain many deft dexterities of diction, but their majestic sonorousness is stagey, not really regal. His "Davideis," as a sacred song (of which only a third was completed), suggests even to Sprat, his editor and biographer, "a boy attempting Goliath"—of whose sword the poet says, it was

"A sword so great that it was only fit
To take off his great head who came with it."

There are no verses so finely metaphysical on any physical subject as Cowley's "Hymn to Light," while for variety, fullness, felicity, and, amid all their conceits, moral and mental power, his Odes on Dr. William Harvey, Sir Henry Wotton, Sir Anthony Vandyke, the Earl of Balcarres, Richard Crashaw, as well as that to Mr. [Thomas] Hobbes, are replete with curious quaintnesses, happy turns of expression, apt thoughts, and delicate compliments so numerous that

"Men doubt, because they stand so thick i' the sky,
If those be stars that paint the galaxy."

We are reminded—by the fact that Cowley not only praised her poems but lamented her decease, and Jeremy Taylor addressed his "Discourse on Friendship" to her—that Mrs. Catharine Philips, born 1631, daughter of Mr. John Fowler, and wife of Mr. James Philips, of the Priory, Cardigan, had earned for herself, by precocity almost equal to Cowley's, the title of "the Matchless Orinda" on account of her harmonious, sensible, and graceful verses. Cowley says of her "numbers gentle" and her "fancies high," that

"They are than man more strong, and more than woman sweet."

Her translations of Corneille's "Pompey" and "The Horatii" were performed at court by the young nobility, the prologue being spoken by the Duke of Monmouth. Dryden thought highly of her verses. The following stanza, from an "Ode against Pleasure," may show their spirit and smoothness—

"Where art thou, then, thou wingéd air,
More weak and swift than fame!
Whose next successor is despair,
And its attendant, shame?
Th' experienced prince then reason had,
Who said of pleasure—'It is mad!'"

Orinda was suddenly cut off by small-pox on 22nd June, 1664. Her works were published in 1667.

Cowley's birth-year, 1618, was that also of Richard Lovelace and Sir Edward Sherburne. The former was a captivating Cavalier poet, "admired and adored by the female sex," who was thrown into prison twice as a Royalist, did daring deeds of fight in France, loved Miss Lucy Sacheverell, of whom he sang as Lucasta [*i.e.* Lat. *lux casta*, chaste light]. This son of Sir William Lovelace, knight, died of consumption in a lodging provided for him by charity, in a miserable alley off Shoe Lane, London, in 1658. His song was gay and musical, but rather given to tinkling trivialities. He is at his best when he puts his own experience into verse.

"Stone walls do not a prison make,
Nor iron bars a cage;
Minds innocent and quiet take
That for an heritage.

"If I have freedom in my love,
And in my soul am free:
Angels alone, that soar above,
Enjoy such liberty."

Sherburne also suffered considerably from the commotions of the Commonwealth. His father was secretary to the East India Company. To this office he succeeded, but was in 1642 ejected and imprisoned. He was commissary-general of artillery at Edgehill, was made M.A. at Oxford, and survived till 1702. He translated Seneca's "Medea" (1648) and his "Troades" (1679). His poems and translations were published in 1651, and his "Astronomicon" or "Sphere of Marcus Manlius," a poet of the Augustan era, in 1675. It contains many valuable annotations.

One of the co-secretaries with Cowley, who conducted Charles II.'s correspondence, was Sir John Denham, poet and dramatist, whose "Cooper's Hill," descriptive of the Thames' scenery about Chertsey, has won universal admiration, and whose "Sophy" (1642), a tragedy of Turkish passion—love, jealousy, revenge, and murder—founded on an incident related in Sir Thomas Herbert's "Travels," regarding Emirhamze Mirza, came upon the public, as Waller said, like "the Irish Rebellion, threescore thousand strong." He was the son of an Irish chief baron, gambled away his estate, turned to poetry, and was knighted after the Restoration. He died March, 1668.

Andrew Marvell came later, and was a man of a different stamp. He won, even in the depraved age in which he lived, the respect of all parties by stainless integrity of character. We are rather concerned with the literary than the political life of this intimate friend, assistant, and admirer of John Milton. He was born in the parsonage of Winestead, in Holderness, 31st March, 1621. Thence his father removed to a lectureship in Trinity Church, and the mastership of the Grammar School of Hull, where Andrew was educated, and whence he proceeded on an exhibition to Trinity College, Cambridge, 1633. Here he was inveigled by the Jesuits, but reclaimed. Having passed B.A., 1638, after the death of his father by accidental drowning, he travelled in France, Holland, Switzerland, Italy, and Spain. His description of Holland has, as Dr. Grosart says, "the cruel fidelity of a photograph." On his return Marvell moved among the monarchists, and was tutor to Mary Fairfax (afterwards Duchess of Buckingham), at Nunappleton, where he wrote many bright, simple, pure, fresh verses, aglow with country life and sunshine of spirit; yet yearning thus—

"If gracious Heaven to my life give length,
Leisure to time and to my weakness strength,
Then shall I once with graver accents shake."

He soon got engaged in politics. Besides being Milton's assistant, Cromwell appointed him tutor to his nephew. He entered Parliament as member for Hull, 1658–59, and continued so till the sudden oncome of the end, 18th August, 1678. He was buried in St. Giles-in-the-Fields.

"But whether art or fate untwined his thread
Remains in doubt. Fame's lasting register
Shall leave his name enrolled as great as theirs
Who at Philippi for their country fell."

Mary, widow of Andrew Marvell, gave her imprimatur (on 20th October, 1686), to a small folio, containing among other things forty-six out of the seventy-two poems of her husband, to whose will she administered 19th March, 1678–79. We give but eight lines of his on "Paradise Lost," but how much does he say in them!

"Thou hast not missed one thought that could be fit,
And all that was improper dost omit; . . .
Where could'st thou words of such a compass find?
Whence furnish such a vast expanse of mind?
Just Heaven, thee—like Tiresias—to requite,
Rewards with prophecy thy loss of sight. . . .
Thy verse, created, like thy theme, sublime
In number, weight, and measure, needs not rhyme!"

The simple airiness and dainty diction of the two following stanzas, from "The Mower to the Glow-worm," are evident:

"Ye living lamps by whose dear light
The nightingale does sit so late,
And, studying all the summer night,
Her matchless songs does meditate.

"Your courteous lights in vain ye waste,
Since Juliana here is come;
For she my mind hath so displaced,
That I shall never find my home."

Henry More, one of the fine Plato-like thinkers who put into poetry the finer essences of mind as sweetly and naturally as the grape matures its luscious clusters, was the seventh son of Alexander More, often mayor of Grantham, and his wife Anne Lacy, and was born 10th October, 1614. After attending the grammar school of his native city, his uncle sent him to Eton, whence he proceeded to Christ's College, Cambridge, and was placed under Chappell, the tutor of Milton. He took his B.A. 1635, M.A. 1638, was chosen fellow and tutor, and ordained deacon in that same year. In 1641 he was admitted priest, and in 1642 was instituted to the "family living" of Ingoldsby. He had no vocation for the pulpit, was a non-resident, and devoted himself to books and thought—"in the freeing of his soul from self and sin." During the Civil War he was left undisturbed. In melodious Greek he mourned, with Milton, the death of Edward King (1637), and took his share often in shedding dewy tear-drops over many noteworthy sorrowful incidents. But his earliest great poem, "Psychozoia," the first part of "The Life of the Soul," is due to 1640. It is the issue of a "joyous and lucid state of mind;" but though capable, as George Macdonald says, of "lifting the soul of man towards a lofty condition of faith and fearlessness," it is neither so compact, systematic, nor perspicuous as, for taking hold of ordinary minds, it should be. Its keenness of vision, serenity of belief, and peculiar poetic beauty of phrase are indubitable. He does not claim for it "the delicacy of some lady-wits that can like nothing that is not as composed as their own hair, or as smooth as their mistress' looking-glasses," and admits that his readers may be "often nonplussed," as

"Possessed with living sense I inly rave,
Careless how outwards do from me flow,
So be the image of my mind they have
Truly expressed and do my visage show,
As doth each river decked with Phœbus' beams
Fairly reflect the viewer of his streams."

How sharply satirical is he on materialists who try to

"Squeeze out drops of light, or strongly wring
The rainbow till it dye his hand, well-prest."

In 1647 his "Philosophical Poems" appeared in a second edition. He treated of (1) the life, (2) the immortality, (3) the unsleepingness, (4) the pre-existency, (5) the unity of the soul, and (6) the infinity of worlds in which the soul may dwell. Besides these he wrote many minor poems, divine hymns, and occasional verses. The metaphysics of religion have seldom been set forth in verse with larger lore and fuller spirit. As a friend of Cudworth, the correspondent of Descartes, and the antagonist of Hobbes, More must have had a vigorous and shrewd mind; but he had become probably over-exquisite in speculative fancy, and felt firmly persuaded that he wrote under distinct divine influences. After forty years' longer dreaming in his Academe he passed calmly away, 1st September, 1687.

More's opponent in religious views, Dr. Joseph Beaumont, son of John Beaumont of Hadleigh, Suffolk, and of his wife Sarah Clarke, was much less intellectual and more realistic. He was born 13th March, 1616, educated in the grammar school of his "mother towne," where at the age of ten he took part in a comedy written by his master, William Hawkins, entitled "Apollo Shroving," published 1626. He proceeded to Peterhouse College, Cambridge, 1631, took B.A. 1634, and M.A. 1636, having Richard Crashaw there for a valued friend. He was a resolute reader of, and a diligent annotator on, all sorts of books. Being warmly attached to the Royalist cause he was ejected in 1644, and having retired to Hadleigh he then, being "without the society of books," resolved on composing his poem "Psyche," in which he endeavours "to represent a soul led by divine grace and her guardian angel (in fervent devotion) through the difficult temptations and assaults of lust, pride, heresy, persecution, and spiritual dereliction, to a holy and happy departure to heavenly felicity," interweaving a "Life of Christ," as the mystery of eternal love, with the texture of his poem, saying—

"My task, dear Love, art thou; if ever bay
Court my poor Muse, I'll hang it on thy shrine;
My soul untuned, unstrung, doth wait on thee,
To teach her how to sing thy mystery."

When first published in 1648 it consisted of twenty cantos; in the second edition, issued "because often and earnestly desired," by his son Charles, it was corrected (we dare scarcely say improved) throughout, and enlarged to twenty-four. It contains 38,742 lines, and is one of the longest didactic poems in our language. Besides holding several non-resident livings, he became in 1650 domestic chaplain to Matthew Wren, bishop of Ely, whose step-daughter, Miss Brownrigg of Tattington Place, he married, and time went with him sunnily and tranquilly notwithstanding the troubles. On the Restoration he was made one of his Majesty's chaplains and D.D., 18th August, 1660. While canon of Ely his wife died, 31st May, 1662. Bishop Wren appointed him, in place of Beilby Porteous, Expositor of the Creed, Master of Jesus College. Thence he was transferred to Peterhouse, over the head of the famous Isaac Barrow. In 1665 he privately admonished Dr. Henry More, and asked him to retract certain of his opinions as "most dangerous and heretical." More instantly resented his interference, and a serious controversy ensued. Beaumont was chosen King's Divinity Professor in 1674. He preached before the university, 5th November, 1699, when slightly ailing; a high fever supervened, and to this he succumbed on the 23rd. Beaumont is not by any means an enlivening singer, though there are dainty memorable things (as well as *outré* and tasteless ones) in the lengthy lapse of his leisurely lines. Both are observable in this one out of fifteen stanzas descriptive of Eve—

"Eve! topstone of the goodly-framed creation,
The bliss of Adam and the crown of nature;
Eve! who enjoys the most removed station
From ugly Chaos; Eve! that final creature,
In whom the Almighty Lord set up his rest,
And only spared to say—*He'd done his best!*"

John Dryden ("Glorious John," as he is frequently called) was the son of Erasmus Driden of Blakesley, near Tidmarsh, and Mary Pickering. He was born [Pope dates] 9th August, [and the poet states] 1631, at Aldwinkle, All Saints, London. He was educated at Westminster School and Trinity College, Cambridge. He took B.A. 1653–54, but did not take M.A., his father having died June, 1654, though he resided at Cambridge till 1657. Then, being disappointed in his love-suit to his cousin, Honor Driden, he went to London and engaged in business, probably as secretary, under his mother's cousin Sir Gilbert Pickering, member of Cromwell's Privy Council and of his House of Lords. On the great Protector's death he wrote, along with Waller and Sprat, some verses; but at the Restoration the family interest of the Dridens and Pickerings came to an end, and the latter was remitted to his Northampton estate. John Dryden, left to his own resources, composed his "Astræa Redux," congratulating the monarch on his happy return, and had a good many to keep him company in his tergiversation. From that time onward his life was political, polemical, and poetical. Like Milton, he had the power of reasoning in verse, on which account Walter Savage Landor designates him "the Bacon of the rhyming crew;" but he had not in him the same sense of sublimity and beauty. As a satirist he was without equal, and in their lively lyrical ring his odes are unmatched by any writer of his age. Like Milton, he too had a dream of making "King Arthur" a national epic; but the absurd taste of his age drove him to make it the libretto of an opera, with music by Purcell (1691). After that the topic was made ridiculous by Sir Richard Blackmore, M.D., who in 1695 produced "Prince

Arthur," and continued it in 1697 as "King Arthur." Richard Hole did rather better in his "Arthur" (1789). In 1848 Lord Lytton adopted the fable with a modern guise, and only recently, in Tennyson's "Idylls of the King," has an Arthuriad possessing genuine poetic merit been given to British literature. Not epic but dramatic poetry was that which promised best to a professional literary man like Dryden. The drudgery of prose even did not pay, and was precarious; but the stage offered a livelihood. Within a quarter of a century he wrote eight and twenty plays, all of which have dropped out of the acted drama; most are tainted with grossness, many are unread, and a few supply in detached passages fine rhetoric, but little poetry; as—

"Secrets are edged tools,
And must be kept from children and from fools."

"So blind we are, our wishes are so vain,
That what we most desire, most proves our pain."

"Then setting free a sigh, from her fair eyes
She wiped two pearls, the remnant of wild showers,
Which hung like drops upon the bells of flowers."

"The bold are but the instruments o' the wise,
They undertake the dangers we advise;
And while our fabric with their fame we raise,
We take the profit and pay them with praise."

Dryden, in December, 1663, married Dame Elizabeth Howard, daughter of the Earl of Berkshire; in 1666 he wrote the "Annus Mirabilis," giving in the verse of Gondibert an account of the Dutch war, and the fire in London of that "wonderful year." In this year James Howell, royal historiographer, died; two years later Davenant, the poet laureate, also passed away. Both offices were in 1670 conferred on Dryden. When the struggle between the Dukes of York and Monmouth for the English throne was distracting the country Dryden produced a famous political satire, "Absalom and Achitophel" (1681), in which Monmouth appears as Absalom, the Earl of Shaftesbury as Achitophel, and George, duke of Buckingham, as Zimri; France is called *Egypt*, England *Israel*, Scotland *Hebron*, and London *Jerusalem*. The easy elasticity, rapidity of movement, and variousness of power exhibited in this poem Dryden never surpassed. It was translated into Latin (1682) by Francis (afterwards Bishop) Atterbury. A medal having been struck to commemorate the refusal of the grand jury to find a true bill against Shaftesbury, Dryden produced "The Medal," a satire against sedition. Next year Dryden published "Macflecknoe, or a Satire on the True Blue Protestant Poet, T[homas] S[hadwell]," dramatist, and his successor in the laureateship. This rhymster, who, Dryden avers, "never deviates into sense," he describes as the son of Richard Flecknoe, a poet, dramatist, and miscellaneous writer, who

"In prose and verse was owned without dispute
Through all the realms of nonsense absolute."

John Wilmot, earl of Rochester, who, from a great scoffer and gross sinner, became, when worn-out by his sensuality, convinced of his folly and faults, and changed his opinions and manners, wrote many sprightly trifles and some trenchant satires. Of the former his verses on "Nothing," though the idea is borrowed from Passerat, is clever; his "Satire against Man" vigorous, and his "Trial of the Poets for the Bays" racy and stinging. Passing over Mrs. Behn, Dryden, D'Urfy, Etheredge, Otway, Settle, Shadwell, and Wycherley, Wilmot gives the Bays to Thomas Betterton, player and playwright, who gained the warmest praise in the former character, but the most moderate in the latter. Dryden had resented, as Rochester thought, this attack in an "Essay on Satire," and in revenge had him waylaid and beaten by hired ruffians in 1679. On Settle and Shadwell, who were patronized by Rochester, Dryden launched his bitterest darts in many pungent rhymes. In 1682 Dryden's "Religio Laici" [The Layman's Religion] was published. It was a recoil from Lord Herbert of Cherbury's "De Religione Laici" (1645), in which it was maintained that ordinary people can never attain to any religious certainty. In this poem Dryden sketches the chief points of faith, and inclines to the reception of traditionary teaching, holding that—

"In doubtful questions 'tis the safest way
To learn what th' unsuspected ancients say;
For 'tis not likely we should higher soar
In search of heaven, than all the church before;
Nor can we be deceived, unless we see
The Scriptures and the Fathers disagree."

In 1685 he accepted the creed of the Roman Catholic Church, and in 1687 issued "The Hind and the Panther"—the former the Romish, the latter the English Church. These hold a disputation together, while James II. is the lion who protects the hind. The bear, the wolf, the hare, the ape, the boar, and the fox are made respectively the representatives of the Independents, the Presbyterians, Quakers, Freethinkers, Anabaptists, and Arians. Of this poem, the fable of "The City and the Country Mouse," by Prior, is an amusing satirical imitation and close parody; for example,

"A milk-white *hind*, immortal and unchanged, [mouse]
Fed on *the lawns* and *in* the *forest* ranged; [soft cheese, o'er, dairy]
Without unspotted, innocent within,
She feared no danger, for she knew no *sin*. [ginn]

By altering the italic words to those in the margin, we have

"A milk-white mouse, immortal and unchanged,
Fed on soft cheese, and o'er the dairy ranged;
Without unspotted, innocent within,
She feared no danger, for she knew no ginn."

On the accession of William and Mary, Dryden, refusing to take the oaths, was evicted from the laureateship and other offices. These were bestowed on Shadwell. This incident did not lower the estimate held of him as a poet, nor check his ardour in literary pursuits. He translated Juvenal, Persius, Virgil, a good deal of Ovid, and the first book of Homer's "Iliad." He also adapted to English literature a version of Boileau's "Art of Poetry," done by Sir William Soame in 1683. Amid severe toil and sore discouragement he kept up his stately and resounding style, and struck off in one sitting the quickening energetic ode, "Alexander's Feast." It is somewhat astonishing that he who could so appreciate Milton as to write under the picture of Milton, prefixed to his "Paradise Lost"—

"Three poets, in three distant ages born,
Greece, Italy, and England did adorn;
The *first* in loftiness of thought surpassed,
The *next* in majesty—in both the *last*;
The force of Nature could no further go,
To make a third she joined the other two,"

should within a year of that poet's death do what Andrew Marvell feared some one might venture to attempt with his greatest work, viz. "change its scenes and show it in a play." In 1675 Dryden, after a month's labour, produced "The State of Innocence and Fall of Man," which, though a tragedy in heroic verse, he called an opera. It was not (and is indeed unfitted to be) placed upon the stage. His latest great task was the modernization of Chaucer and the versification of some of the prose tales of Boccaccio in "Fables" (1700). These display flexible phrase, warmth of imagination, and metrical skill, though some of the original tales added by him scarcely commend him to good taste as an inventor. While feeling the stress of work and the pinch of poverty, he was suffering, too, the pangs of disease. After a severe fit of gout, erysipelas in one of his legs, ending in mortification, brought his life to a close, 1st May, 1700.

Matthew Prior, son of a carpenter in Wimborne, Dorsetshire, was born 21st July, 1664, and educated at the Old Grammar School of that town. He was brought up as a Nonconformist, but was early sent to help his uncle, Samuel Prior, who kept the Rummer Tavern at Charing Cross. Here he attracted the notice of the Marquis of Dorset, who placed him in Westminster School under Dr. Busby. Thence he proceeded to Cambridge in 1682, where he took his B.A. in 1686, and gained a Fellowship, which he retained during his life. There he was received into the best society, was noted as a wit, and acquired distinction as a sort of poetic panegyrist of the period. Here Prior secured the friend-

ship of Charles Montagu (afterwards Earl of Halifax), who soon, at the suggestion of Fleetwood Shepherd, Esq. (himself a town-lyric writer), made him secretary of the embassy at the Hague. Subsequently he was made gentleman of the bedchamber to the king. About this time he composed rhymes rather spiced with naughtiness than tinged with poetry, and made love to "Philomela," Miss Elizabeth Singer (afterwards Mrs. Thomas Rowe), who attained some celebrity as an essayist and poetess. In 1697 he was chief secretary of state in Ireland. He was some time secretary to the embassy in France, succeeded John Locke at the Board of Trade, became M.P. for East Grimstead, Sussex, in 1701, seceded from Whiggery to Toryism, and as court poet flattered the queen and celebrated Marlborough's success at Ramilies. He was minister-plenipotentiary to the French court, and had the appointments of an ambassador. In this office he was succeeded by the Earl of Stair. He was in 1715 impeached and ordered into custody, and was excepted in 1717 from the Act of Grace. His public life ceased, he issued his poems by subscription—which produced £4000—and retired to Down Hall in Essex, granted to him by Lord Oxford. He died at Wimpole, near Cambridge, of a lingering fever, 18th September, 1721, and was buried, at his own desire, in Westminster, leaving £500 by will to erect a monument to his memory therein. His life was loose and sensual, his humour and his wit—like his favourite company—low. Though his singing strikes one as somewhat *falsetto*, yet he gives polished ease, vivacity, and epigrammatic point to several clever sayings, including a good deal of rakishness. His "Alma" is confused and rambling, his "Solomon" flowing and graceful in expression, and his "Henry and Emma" inferior to its original, "The Nut-browne Maide." Everything he did was *miniature* and smart, but even his best work should be regarded as *vers de société*, not *poems*. One of his neatest sayings, which may be compared with More's lines, is calling Eve's

"The original face
Whose beauty was to furnish all the race."

This period was distinguished by having within its space a mob of gentlemen who wrote with ease. It has distinguished poets, too, as we have shown—both favourable and unfavourable to the throne. It was a period in which the active romance of reality translated itself into deed, and the fine fancy of the poet heightened the high principle of the patriot, whether on the side of Crown or Commonwealth. Poet of deed and poet of word alike have been true "makkars" of the varied and vigorous life of Great Britain.

HISTORY.—CHAPTER XVII.

NAPOLEONISM—THE CONSULATE AND THE EMPIRE.

Napoleonism may be used as a general term to indicate the idea which underlies the whole career of that enthusiastic and successful impersonation of government by centralized power. It embraces not a life only of unexampled interest, but a period of unparalleled eventfulness and an ideal of intense fascination—power as the pivot of civilization. The practical doctrine that "might is right" may be held as firmly by the autocratic monopolist of power as by the most democratic anarchist. The converse, that "right is might," may be adopted as truly by monarchist as by socialist. But it depends largely on the interpretation given to the phrase in the minds of those who adopt it, whether its adoption will be beneficial or injurious to the life of civilization. Taken in a good sense, either maxim may mean at least one or other of three ideas, according to the conditions of national development to which it is applied—(1) the reign of will by administration—Imperialism; (2) the reign of law by institutions—Limited Monarchy; and (3) the reign of right by constitution—Federal Government. In this threefold form—in which (1) might is the measure of right, (2) might and right are correlated in innumerable degrees of subordinacy one to another, and (3) right is the measure of might—government is, in all civilized lands, found. Just as the mere might diminishes in influence and exercise, and real right increases in authority and weight, are peace, prosperity, and progress secured. Napoleonism was intended to be the imperialism of intelligent might—a despotism beneficent perhaps in its ulterior aims, but certainly arbitrary in its immediate claims.

The year 1796 was signalized by the failure of the Bank of England (25th February); the refusal of the purest patriot of modern times, George Washington, to hold the reins of government for a third term of presidency (4th July); the death of the Empress Catharine II. of Russia (17th November); the discomfiture of La Hoche's expedition for the invasion of Ireland, at the invitation of the rebels (December); the declinature by France of England's proposals for peace, and the conquering march of Napoleon through Italy.

Napoleon Bonaparte was born at Ajaccio, 15th August, 1769. His father, Charles Bonaparte, a noble of Corsica, died at the age of thirty-two. His mother, Letizia Ramolino, was remarkable alike for beauty and intelligence. Napoleon was admitted as a king's pensioner to the military school of Brienne, 1779. Here he continued for five years, making fair, but not extraordinary progress in his studies, except in mathematics, wherein he excelled, and impressed both pupils and teachers by his domineering, imperious, and headstrong disposition. He was sent on to the military school of Paris to complete his professional education. Just after his father's death he received his commission as lieutenant of artillery in 1785. When, in August, 1792, the Marseillaise marched to attack the Tuileries, in Paris, he was engaged in opposing them, and was promoted to a captaincy. When the Convention sought to defeat the Spanish and English fleet at Toulon, 1794, Napoleon was made chief of a battalion, had charge of the artillery during the siege, and was made general of brigade in recognition of his services. Falling under suspicion of being favourable to Robespierre, he was for some time unemployed, in disgrace, and in serious poverty; but when the Directory was reduced to extremities by the reactionary insurrection of October, 1795, and General Menou was unable to quell the tumult, Napoleon was called to undertake the terrible duty. It was done quite coolly. Despatching Murat overnight to Sablons for fifty pieces of artillery, Napoleon had them so disposed as to command the main lines of the city, and swept the streets clear with shot. He was shortly afterwards made General of the Interior.

Prior to this he had formed a plan for leaving Europe, where nothing practical was possible, and endeavouring to do among Asia's 600,000,000 something of note. He had also made the acquaintance of Josephine, widow of Viscount Alexandre de Beauharnais, and fallen under the fascination of that Creole leader of Parisian fashion. Barras, Carnot, and Tallien conferred on Napoleon the command of the Army of Italy, 23rd February, 1796. On 9th March he married, by civil process, the gay Beauharnais, and in a few days afterwards set off to head his troops. They were in a dreadful state of disorganization. He led them round the Alpine passes, separated the Austrians from the Piedmontese, and gained in rapid succession the victories of Montenotte, Millesimo, and Dego; he drove the Sardinian army at the point of the sword, crushed it at Mondovi, and forced Victor Amadeus III. to sue for peace and cede Savoy. Then turning against the Austrians, he pursued Beaulieu, had a sharp engagement with him at Fombio, and by the daring of his grenadiers swept his enemy from the bridge of Lodi, took Milan, blockaded Mantua, and imposed a fine of 20,000,000 francs on Lombardy. Enormous plunder enriched the troops, and the golden harvest delighted the Directory. Thus closed the first Italian campaign. In the second he imposed peace on the Duke of Parma, Modena, and reduced Pope Pius VI. to sue for terms. The Directory again had its treasury pleasantly replenished. An Austrian army commanded by Wurmser was destroyed, one half at Lonato and the other at Castiglione. That general brought a fresh body of troops into Italy; Bonaparte attacked and routed it at Bassano. Wurmser resolved to force his way to Mantua, and with bullheaded resolution drove on, surprising the French at Legnago, at Cerea, and several other places, till he gained his point, 14th September. He was rapidly followed by the French commander, who put him under siege. This is called the second Italian campaign. Alvinzy brought a new army,

resisted Bonaparte successfully at Caldiero, but, after a hardly-fought three days' battle at Arcole, was overcome. Returning to the fray, Napoleon drove Davidowich out of Verona, beyond Ala and Roveredo; and so ended the third campaign. Alvinzy led along the Adige towards Rivoli another Austrian force. Of this Napoleon heard, and hastening from Verona, dashed on him at Rivoli, and though twice repelled, carried the day. Thereafter he took Mantua, granting the aged Wurmser honourable terms. Pius VI., who had found himself unable to meet the immense demands of the Directory, declined payment, and put his troops in motion. These Napoleon speedily routed, and advancing to Tolentino, enforced the people to sign a treaty promising 30,000,000 francs, and many paintings, statues, MSS., &c., giving Ancona as security. The Archduke Charles of Austria was withdrawn from his victorious career in Germany, where he had been almost as redoubtable as Napoleon in Italy, to encounter the French hero on Venetian plains. Flushed with Bavarian successes, Charles brought 30,000 of his best Teutonic troops with him. Here the tug of war was resolutely begun between the foemen. The Tagliamento flowed between them. The Archduke led raw troops into a new country with unknown dangers before them; Napoleon headed troops whom he had enriched, given ambition to, inured to fight. With skill and daring he forced the passage of the river, drove the Austrians before him out of the Venetian plains, into and from the passes of the Alps, planting the French flag on the last ridge of those mountain-battlements. On 7th April he entered Leoben, and then, pushing on his vanguard from the Simmering, the Viennese steeples were seen only eight days' march off. Slowly and calmly, though wisely, the Archduke retreated, training his troops for future exploits; the Austrians became alarmed, and by the treaty of Campo-Formio, 17th October, 1797, ceded the Netherlands, Lombardy, and some other small portions of territory to France, while they received the territories of the republic of Venice in exchange. Napoleon, knowing he had ventured too far into the Austrian dominions, feeling the full peril of his position, gladly concluded this peace, with treacherous selfishness ceding a republic which had worked out a revolution in favour of France.

Napoleon had fulfilled the promise he had held out to the army when he found it—cold, famine-stricken, and naked: "I will lead you where you will find comfort, wealth, and glory;" he had obeyed the Directory in providing them with the produce of military plunder; he had tasted the pleasure of power; and he had learned the mastery of mobs of men. He had himself come under the magical influence of seeing the very territories of the mightiest nation of conquerors—the lands over which Cæsar ruled—trodden by the troops of France under his guidance, the troops of that France of which Charlemagne had made himself sole master. His early readings of the achievements of the great captains who had swayed the most extensive empires in ancient and in mediæval times had received for him intensity and interpretation by the incidents and the results of these campaigns. Why should he not do that for himself which he had done for, and yet trammelled by, the Directory? He knew the adoration men feel for force, the ardent passion of his countrymen for military glory, the homage given to those who seem to advance man's material interests, the readiness with which the masses succumb to any energetic affirmation of distinct individuality, and the fondness of France for resounding rhetoric. He knew the weakness and insincerity of the Directory, the need that France had for some means of replacing the waste of wealth occasioned by the Revolution, and that when his soldiery, spread through the country, should tell their tales of conquest and exhibit the spoil they had taken, the greed alike of gold and glory would act like an infection. A personal programme began to present itself as a possibility, and the thought gained life—Why may I not also now open a new volume in the history of the world?

When, in December, 1797, Napoleon arrived in Paris enthusiasm was aflame. The Directory found their general sufficiently sensible that he had "done the state some service," and the fervour of the people for their fortunate favourite excited jealousy and apprehension. Remembering his early visionary idea of great possibilities in the East, and unwilling at that time to yield to his scheme for conquering England, a compromise was effected. This was the fitting out of an expedition to Egypt, as a step towards the retrieval of the power which France had lost in India. France was then at peace with Turkey; but that did not matter to the Directory, that wished Napoleon anywhere but in France, or to Napoleon, who desired to win renown as the means of achieving power. Admiral Brueys, commanding a squadron of fourteen ships, carrying 35,000 soldiers, besides engineers, artists, and *savans*—with Napoleon as commander-in-chief—quitted Toulon, 19th May, 1798. They reached Malta, 9th June, and this they besieged. It capitulated on the 11th, and was as unmercifully plundered as it had been treacherously surprised. On 29th June they reached the mouth of the Nile, disembarked, took Alexandria by assault (1st July), and marched on Cairo. The Mamelukes prepared to resist. Napoleon, halting beside the Pyramids, drew up his forces, and addressing them, cried out just before he gave the order for battle, "Soldiers, from the summit of these pyramids forty centuries look down upon you!" The Mamelukes were defeated, Cairo was taken, and Lower Egypt was subdued. Bonaparte organized the country, attended the festivals of the Nile and of Mohammed, and inaugurated L'Institute d'Egypt, whose members were Monge, Berthollet, Fourier, Larrey, Geoffrey Saint-Hilaire, &c. Meanwhile Nelson, who had been delayed by contrary winds, appeared in Aboukir Bay (1st August), and next day, by destroying Brueys' fleet, cut off Napoleon's communication with the Continent, and imprisoned him in his conquest. The Sultan declared war, revolt arose in Cairo, and by horrible massacres, ordered by Bonaparte, the insurgents were suppressed. He then resolved on an expedition through Syria, that he might seize the throne of the East at Constantinople. He crossed the desert which lies between Africa and Asia; took Gaza; stormed Jaffa, massacring 4000 prisoners; besieged Acre; dashed on to Nazareth, and with immense slaughter defeated 40,000 Ottomans at Tabor. Acre, the key to Syria, was defended by Pasha Djezzar, Colonel Phillippeaux, an old schoolfellow of Napoleon's, and Sir Sidney Smith. After sixty days' siege, and the loss of 3000 men, Napoleon Bonaparte raised the siege, and—having poisoned his own wounded soldiers—returned unsuccessful to Cairo, 14th June, 1799. In July the English landed 20,000 janissaries at Aboukir, and on the 25th, Napoleon having fallen upon them, destroyed one half by shot, bayonet, and driving them into the sea.

During his absence Suwarrow, with an Austrian and Russian army, had defeated the French in Lombardy, regained the fortresses of the Alps, and was nearing Provence. The Archduke Charles and Korsakoff had driven Massena, even at the head of 50,000 men, within the frontiers of France. Jourdan lost at Stockach, Scherer at Magnano, Moreau at Cassano. Everywhere defeat was darkening into despair. The Directory was profligate and inept; they were quarrelling with each other and the legislative councils. The French yearned for military glory, and believed it better that their soldiery should despoil other lands than that they should suffer spoliation. The failures of the generals of the Republic excited them to a frenzied fondness for him whose sword brought conquest and wealth. Napoleon heard all this when he was in difficulty, in danger, and at a distance. "The pear is ripe!" he said, and set sail for France. On 9th October he landed in the Gulf of Fréjus. He was two days in Paris before the Directory knew of his arrival. His designed dominion was within Napoleon's grasp. On 10th November Murat, with a detachment of grenadiers, cleared the Senate House, and three provisional consuls, Abbé Sièyes, Roger Ducos, and Napoleon Bonaparte were appointed. On 24th December the Consulate was accepted by 3,011,007 votes to 1567 against. Napoleon, who had taken up his residence at the Luxembourg, soon removed to the Tuileries, and wrote to the King of England expressing a desire for peace. At this very time he was preparing his plans for the annexation of Switzerland, Nice, Savoy, and the Netherlands, and for the expulsion of the Germans from

any power on the left bank of the Rhine. He reformed the administration, replenished the exhausted treasury, repealed the laws relating to opinions, reopened the churches, and closed the struggle in La Vendée. But he knew that France could not now enjoy the calm and unexciting life of peace —that glare and glitter, excitement and occupation, were all essential to the theatricality of a despotism of individuality. War was absolutely indispensable in an empire of paternal proletarianism which, by the sheer strength of superintendence, should crush the free will of the people with the power of a master, instead of cultivating its conscious effectiveness with the carefulness of a guide. To secure his centralizing despotism he commanded the draft of a code of civil law, the institution of a national education in which practical information should be encouraged and self-culture discouraged, so that tools and agents might be plentiful, and independent minds and men should be few. France was a great barrack under daily despotic drill.

Napoleon resolved to renew the war in Italy, where memories of success marked each scene. Assembling at Dijon, in secret, an army of reserve, he suddenly led them across the Pass of St. Bernard, stormed the fort of Bard, entered Milan, 2nd June, defeated the advanced guard of Austria, at Stradilla, on the 13th, and met the main body under Melas at Marengo, 14th June. Here he caught them, their faces towards Vienna, and behind them the maritime Alps and the Gulf of Genoa. His triumph was complete, the slaughter terrible. Melas resigned the fortresses of Piedmont and retired to Mantua. The first consul made a triumphal entry into Paris, 3rd July. The French army, under Moreau, crossed the Upper Rhine, 25th April, defeated Kray in several engagements, and had reached Ulm, when the news from Marengo arrived. Nerved by this, Moreau crossed the Danube, drove the Austrians from their camp, overran Bavaria, took Munich, and was ready to invade the imperial dominions. Bonaparte tendered conditions of peace. Austria would not treat without England, and the consul, fearing the issue of affairs in Malta and Egypt, demanded an armistice. Britain refused, war was recommenced. Three armies were defiled from France at once. That of Italy, under Brune, drove the Austrians from the Mincio, and advancing beyond the Adige and the Brenta threatened Venice. Under Macdonald the passes of the Tyrol were occupied by a force ready at a word to aid Brune or Moreau, who, in Germany, marched upon Salzburg and Vienna. Near Haag Prince John met and repulsed them; but on 2nd December, at Hohenlinden, between the Iser and the Inn, Moreau drove him from the field with the loss of 10,000. The way to Vienna was now open to the three armies, and the emperor besought an armistice 25th December, and on 9th February, 1801, the treaty of Luneville was signed. Shortly thereafter Sir Ralph Abercromby and General Moore succeeded in wresting from Menou all Napoleon's conquests on the Nile, and Egypt was evacuated by the French, 2nd September, 1801. Malta was surrendered to the British troops 15th September. The Emperor Paul of Russia, at once dazzled and dismayed by Napoleon's portentous career, ceasing to be an ally, became an enemy of Britain. He, under French influence, formed the Confederacy of the North—Denmark, Sweden, and Russia—to destroy the commercial supremacy of Britain. Pitt believed that one blow would shatter this coalition. It was given by Nelson. The very news of the movement of his fleet led to the assassination of the emperor, 24th March. On 2nd April Nelson's hardest fought battle, at Copenhagen, opened the Baltic to the British fleet, and on 17th June a convention was signed at St. Petersburg dissolving the confederacy, and confirming and enlarging the commercial privileges of Britain.

In the meantime a Concordat, forced upon Cardinal Consalvi, 15th June, 1801, was concluded April, 1802, between Pope Pius VII. and Napoleon, by which the clergy of France became, like laymen, subject to the civil power in temporal matters. Napoleon was made President of the Cis-Alpine Republic (January, 1802), and under Admiral Linois the naval force, which the consul had been for a long time patiently constructing for a conflict on the sea, tried its strength against Saumarez, gained a victory in the first struggle, but was completely worsted in the second, at Algeciras, in Spain (June, 1801). By the peace of Amiens, 25th March, England agreed to restore its colonies to France, Malta to the Knights of St. John, and the Cape of Good Hope to the Dutch, besides recognizing the treaty of Luneville. To outward peace Napoleon added internal organization. He especially instituted the Bank of France, and so interested the capital of France in the stability of his power; and the Legion of Honour, and so brought all the ambitious and vain under the influence of the ordainer of this decoration. Besides these, he instituted great public works; three bridges were thrown across the Seine, the canal of St. Quentin was cut, and the Simplon Pass was made a highway between France and Italy. France, quite charmed into love of absolutism, elected Napoleon Consul for life, with the right to choose his successor, 2nd August, 1802. Piedmont was united to France, and arranged in seven new departments, 1st September; the Duchy of Parma and the Isle of Elba were occupied. To Switzerland, with the aid of 20,000 men, France gave a new constitution as the Helvetic Republic, 9th February, 1803. Thus, though Britain had made peace that the increasing power of Napoleon might be stayed, France's unresting spirit contrived the enlargement of its borders. While Britain, in an economical fit, reduced its national armaments, the consul prepared a large fleet intended to contest the sovereignty of the sea. Seventy ships of the line were assembled in the channel. In these he intended to embark 130,000 for England, and in 2000 gunboats to send off 30,000 from Boulogne to Ireland. A fleet from Toulon set sail for Cadiz, and led Nelson away in pursuit of them to the West Indies. Having evaded Nelson's squadron they returned; but, being met by Sir R. Calder off Finisterre, they were defeated, and instead of reaching their reinforcements at Brest they retreated to Cadiz. There, in Trafalgar Bay, they were ultimately vanquished by Nelson, 21st October, 1805. England's sailor-hero died amid the thunders of that victory which conferred upon him the crowning glory of annihilating Napoleon's hope of stretching sword or sceptre over the sea.

Of course the peace had only been an armistice. Britain's remonstrances against Napoleon's extensions of territory and threatening preparations had been irritatingly contemned, and war had been declared against France, 18th May, 1803. Britain granted reprisals against the ships, goods, and subjects of France, and laid an embargo on all ships in British ports belonging to France, Holland, or any other country occupied by French arms, and Napoleon detained every English person in France (10,000 in all) as a prisoner of war. A French army was sent to the frontiers of Holland; Mortier invaded Hanover, levied military contributions therein and from the Hanse towns, and besides this declared the navigation of the Elbe and Weser closed. Conspiracies now began to be entered into. Though the "Infernal Machine Plot," 24th December, 1800, had led to the consulate, George Cadoudal and Pichegru entered into a conspiracy in favour of the Bourbons (February, 1804), in which Moreau, the hero of Hohenlinden, was implicated. Moreau escaped to the United States, whence he did not return till 1813. The Duc d'Enghien, the last of the Condés, was shot half-an-hour after a show of trial, at Vincennes, 20th March. Pichegru was found dead in his prison-bed in the Temple, 6th April; Cadoudal was executed 25th June. Napoleon, using this conspiracy for his own ends, proposed an imperial government, on 18th May assumed the title and power of Emperor, and on 2nd December was anointed by the Pope. Next year, in the cathedral of Milan, he was crowned (20th May) King of Italy, and made his step-son, Eugène Beauharnais, his viceroy. England stirred the Continent to repudiation of such claims. A coalition was formed with Russia, Austria, and Sweden, and war ensued. Then Napoleon quitted the shores of Boulogne, and, with the astounding celerity and decision which marked his actions, concentrated his forces at Mainz, marched through Bavaria, surrounded General Mack and compelled him to capitulate at Ulm, 19th October, 1805, entered Vienna 13th November; then, hurrying north, he joined issue with

an Austro-Russian army at Austerlitz, and utterly overwhelmed it, 2nd December. Europe was amazed, France overjoyed. Next day Alexander I. sought an interview, sued for peace, and on 24th December the treaty of Presburg was signed; and ultimately Napoleon accepted the Protectorate of the Valley of the Rhine and of Southern Germany, the rulers of which dissolved their connection with the Germanic Empire and allied themselves to France as *The Confederation of the Rhine*, signed at Paris, 12th July, 1806. Francis II. renounced his title as Emperor of Germany, 6th August; he had previously agreed to forfeit that of Emperor of Austria. Napoleon now, since he could not open the sea to his fleets, resolved to close the Continent against Britain. He chased the Bourbons from Naples, and set his brother Joseph on the throne of Naples and Sicily; made his brother Louis king of Holland, his sister Pauline Borghese duchess of Guastalla, his brother-in-law Murat (Caroline's husband) Grand-duke of Berg, and gave twelve duchies in Venetian territories, and four in Naples, to his most devoted companions-in-arms and followers.

Pitt died 23rd January, 1806, stunned by the shock of Austerlitz, even though the news of Trafalgar came to excite a reaction, and Fox, his rival and successor, expired 13th September. The ministry of the Duke of Portland, 25th March, 1807, declared for war *a outrance*. Prussia, when it was too late, though hitherto, moved by selfishness and fear, she had played the spaniel to France, with mad impetuosity rushed into strife. Russia promised two armies, Sweden help, England subsidies, and Austria joined the coalition. With a double stroke Prussia was completely overcome. On the same day (14th October) Napoleon inflicted a terrible defeat on Prince Hohenlohe at Jena, and at Auerstadt Davoust defeated the Duke of Brunswick. He received the sword of Frederick II. at Potsdam. On 1st November Napoleon entered Berlin; on the 21st he issued decrees against British shipping, declaring England in a state of blockade, interdicting commerce with it, and confiscating British merchandise. These decrees were reissued in an embittered style next year at Milan in retaliation for the efforts of the British admiralty. On 28th November, 1806, Murat entered Warsaw, and on 15th December Napoleon also arrived. The Russians were on the Narew, an affluent of the Vistula. English and Prussian reinforcements were arriving by sea. It was necessary to cut off the Russian communication with the coast. With this end in view he, during the depth of winter, fought many destructive skirmishes, but Benningsen sturdily held out, and forced a pitched battle on Napoleon amid Eylau's snows, 9th February, 1807, in which the emperor lost 30,000 men. Gathering all his reserves, and with 150,000 soldiery under his banners, he retrieved his renown by the battle of Friedland, 14th July. Alexander, at an interview with Napoleon at Tilsit, sought peace, and by a treaty signed there Europe was divided between the emperor of old descent and the emperor of the new *régime* of sword-play. Hearing of this treaty, the British sent a naval armament to demand the Danish fleet, lest it should fall into the hands of these imperial colleagues. This was refused, Copenhagen bombarded, and the ships and stores were rescued from Napoleon's grasp. He made his brother Jerome king of Westphalia, and appointed the King of Saxony Grand-duke of Warsaw. This success in the north emboldened Napoleon to renewed efforts in the south. Portugal was seized, the Bourbons of Spain were compelled to renounce their rights, Joseph was transferred to the throne thus vacated, and Murat was advanced to the vacancy at Naples. Britain opposed these changes; Dupont was overcome at Castanos, and capitulated. Wellington won, over Junot, the battle of Vimieiro, and by the convention of Cintra the French were forced beyond the Ebro. Drawing all his reserves together, Napoleon hastened with 200,000 men to Navarre, defeated the Spanish in several engagements—Burgos 10th November, Espinosa 12th, Tudela 23rd, &c.—retook Madrid, where he abolished the Inquisition, and left Soult and Ney to do battle in Galicia. There they lost Corunna, and Britain had to mourn Sir John Moore.

Austria, discovering that Napoleon's chief forces were concentrated in the Peninsula, resolved on recovering some of her old provinces, and declared war, May, 1809. Archduke Charles, with 100,000 men, marched into Bavaria, and had some success; but Napoleon, leaving Spain, met them at Abensberg, and at Eckmuhl and Ratisbon defeated them, and made himself master of Vienna. At the battle of Aspern the Archduke inflicted a defeat on him involving the loss of 35,000 men. This caused Napoleon to seek refuge on Lobau, an island in the Danube. Again, however, he rallied, and, roused by the ruin then imminent, he redoubled his efforts. After two days' fierce fight at Wagram, he issued victoriously from that field. By the peace of Presburg, Austria was deprived of one-fourth of her dominions, and Napoleon won the hand of the Archduchess Maria Louisa, daughter of the emperor, as a preliminary for his marriage with whom the Empress Josephine was divorced 16th December, 1809. He was married again 1st April, 1810, and on 20th March, 1811, that son was born on whom, in his cradle, he conferred the dignity of King of Rome, as the Charlemagne of a new sovereignty. For a while France seemed satiated with military glory, and Napoleon himself sought some rest and joy. He had abolished the tribunate after the treaty of Tilsit, and not even the semblance of self-government was left to that France whose rising for liberty had unsettled every throne in Europe. To the direct taxes previously imposed he added indirect contributions to the finances, and in 1808 he had promulgated his Code of Commerce. Besides this he had instituted great public works—the canals of Ourcq, of Nantes, and Brest, of the Rhine and Rhone; the passes across the Simplon, Genevre, and Cenis; the Canal St. Martin, the Cemetery of Père Lachaise, &c.; and with the cannon taken in battle he constructed the Column Vendôme. In front of the Tuileries he built an arch similar to that of Severus, and at the end of the Champs Elysees one imitated from that of Adrian. The Bourse was begun, and Paris was gratified by beautiful fountains. The immense financial system of France ramified into every part, and golden showers watered the capital and its citizenry.

Alexander resented the tutelage of Napoleon. He could not carry out the Berlin decrees, and the master of the legions of France insisted on implicit observance. Besides, Napoleon felt that it was only by dazzling France with glory and astonishing Europe with power that he could avoid or evade the criticism of calm thinkers. There was now only one foe on the Continent with whom he could measure swords. That one vanquished, his government was invincible on land, and the dominion of the ocean would speedily follow. He declared war against Russia. From every conquered country and allied state he wrung contingents. An army of 640,000—French, Prussians, Austrians, Saxons, Bavarians, Italians, Dutchmen, Westphalians, and Würtembergians—were pressed into service. With this he crossed the Niemen, captured Vilna 28th June, and ravaged Lithuania. The Russian generals retreated, wasting the country, carrying off the supplies, and avoiding any general engagement. He caught Barclay's rear-guard at Ostrowno on 25th July, and occupied Vitebsk on the 28th, but Bagrathion, despite Davoust's efforts at Mohilev, joined Barclay at Smolensk. Napoleon recklessly made after them. He reached that city 16th August. The enemy had left it in flames. He pursued them for three weeks. Kutusoff being sent to supersede Barclay, showed fight at Barodino. A thousand cannon exchanged shots in the battle; the carnage was dreadful. Napoleon was left master of the field, but nothing else, 7th September. A week afterwards he reached Moscow. Rostopschine, the governor, set the place on fire. After a month's stay among the ruins, making proposals of peace to which no heed was given, Napoleon began his retreat, 19th October. He had risked everything in the hope of striking an overwhelming blow. The blow had fallen on his own followers. Three-fourths of them were dead, sick, or taken. He set out by way of Kalouga. At Malo-Jaroslavitz, after the place had been taken and retaken seven times, he was compelled to resume his journey over the twice wasted route by which he had advanced. The cold was intense, the troops naked and starving, surrounded by Cossacks, and constantly exposed to their attacks. On reaching Smolensk (14th November) not a tenth of his army

remained. On reaching Beresina this remnant, pressed by the enemy, rushed in the wildest confusion to the bridges, and little more than 25,000 survived the passage, and 20,000 of these had perished before the Niemen was recrossed under Ney, 30th December, 1812. Napoleon had prior to this hastened to Paris, 18th December, issued a new conscription, and the conspiracy of Malet having been crushed, he was ready, in the spring of 1813, to take the field again with 350,000 men.

But the spell of the conqueror was broken. Europe awoke from its nightmare. Moscow's flames, Russia's snows, and her Cossack hosts, had shown that France was not invincible; but a more distinct proof of this had been given. Arthur Wellesley had drawn the impassable lines of Torres Vedras, on which 600 guns were mounted and guarded by 60,000 troops. Massena had vainly striven to force them, and had been compelled to retreat 15th November, 1811; Soult was defeated at Albuera; Marmont at Ciudad Rodrigo, 12th January, 1812; Badajoz had been taken by storm; at Salamanca Marmont was again worsted with terrible loss 12th July, and Wellington entered Madrid in triumph 12th August. He compelled the complete evacuation of Southern Spain. His campaign in the north of Spain in 1813 had been a continual triumph. King Joseph and Marshal Jourdan were defeated on the plains of Vittoria, 21st June, San Sebastian was besieged and taken, Pampeluna was blockaded, and Soult defeated. The French were chased across the Bidassoa, Bayonne was invested, and Soult was again defeated at Orthez and on the heights of Toulouse—though this happened four days after the peace which Napoleon had been reluctantly compelled to accept; for, encouraged by Wellington's victories in Spain, Prussia and Russia had formed an anti-Napoleonic alliance, which Austria afterwards joined. Bernadotte of Sweden also entered the coalition, and Moreau, the exiled hero of Hohenlinden, had come from America at Alexander's request to take a leading part against his persecutor. They led 500,000 men into the field. Napoleon improvised a counter campaign, and with his 350,000 men dashed with tiger-like agility into the arena. He was successful at Lützen, 2nd, and Bautzen, 21st May. An armistice was agreed upon, 4th June. Napoleon, unwilling to make concessions, fought several battles near Dresden—in one of which Moreau was killed—between 24th and 27th August. But several of his corps had been defeated, and he was unable to maintain his ground. He retreated towards Leipzig. The coalition formed an arc around him of 300,000 men. He made one grand *coup* to break that arc. The struggle was the most murderous in modern history. During 16th and 18th October the contest was intense; on the 19th Napoleon was driven out of the town and retreat was forced on him. On the last day of 1813, with but one-fifth of his host left, he re-entered France. The Senate decreed a new conscription, and with 300,000 men he strove to drive the coalition out of France. After fighting with the intensity of despair, the allies captured Paris, 30th March, and on 4th April Napoleon abdicated his throne, at Fontainebleau, and a British ship conveyed him to Elba, 4th May, 1814.

Before ten months had elapsed, the encaged emperor made his escape from Elba, landed at Frèjus, 1st March, 1815, and having appealed to France, marched on to Paris, which he reached on the 20th. On the way the army almost *en masse* joined him, and while the Congress of Vienna was still engaged in re-arranging the map of Europe, he reassumed supreme power in France—proffered a free constitution to the people, and prepared to try once more "the wager of battle" with the powers. At once, the allied armies, who had evacuated France, were set in motion, to be concentrated in the Netherlands. Napoleon, leading 125,000 men, advanced on Charleroi, 15th June. Next day he attacked Blücher at Ligny, while Ney was sent to drive a-tilt on Wellington at Quatre-Bras. He maintained his ground. Napoleon on the 17th despatched 30,000 men, under Grouchy, to pursue the Prussians under Blücher. Wellington fell back on Waterloo. On the 18th Napoleon engaged in the most memorable and decisive of his many battles. The result was irretrievable ruin, though even to the last a gleam of glory fell on the French in the field. The British squares remained steady. Infantry and cavalry alike reeled back from their stubborn foes, and though the Guards deployed brilliantly in the very face of disaster, the tremendous outburst of artillery and musketry with which they were met, combined with the sounds of reinforcements by the Prussian troops, turned their fine military onset into a melancholy rout. They became confused and gave way. Napoleon, crying "All is lost!" "Save themselves who can!" rushed from the field, hastened to Paris, and signed an abdication in favour of his son. The provisional government of Five desired him to leave France; General Becker was deputed to escort him to Rochfort, whence he intended to embark for the United States. The allies refused to recognize his abdication, replaced Louis XVIII. on the throne, from which he had been so suddenly dislodged. On 15th July, Napoleon went on board the *Bellerophon*, and said to Captain Maitland—"I come to place myself under the protection of your prince and laws." The Island of St. Helena was assigned to him as a residence. On 7th August he was removed from Captain Maitland's charge, to the flagship of Sir George Cockburn, in which he was conveyed to St. Helena, 16th October. There he was retained as an exile-prisoner. His health gradually became impaired, and at length he died of cancer in the stomach, 5th May, 1821. He was buried in Slanes Valley, with military honours, but at the request of France his body was removed to Paris and re-entombed in the Hotel des Invalides, with great ceremony, 15th December, 1840.

So ended the personal life of one of the most noted warriors of the world. Of his capacity as a leader of men and an organizer of institutions there can be no question. He was a man of immense force of character—an incarnate self-will. Never has there been a less hesitant promulgator of the creed—

> "That he should take who has the power,
> And he should keep who can."

The Napoleonic idea is not the world for the worthiest, but for the mightiest and most selfish. Greatness in those combinations of force which have made Europe a chess-board on which the combined game of chance and skill—war—is played with empire for the stake, may fascinate and enthrall; but there is a greatness which excels the mere warrior's might—the greatness of civilization [*i.e.* the highest and widest happiness attainable in any given age by man]. The French Revolution was an insurrection against the feudal civilization, which placed the main outward means of happiness in the hands of the noble. Napoleonism came bribing mankind with the enrichment derivable from the distribution by spoliation of the accumulated means of happiness gathered during ages. France was at first enriched and dazzled by its easily-won wealth. Instead of the diminution of its population by the guillotine, it was accomplished by the duel of battle and with the glare of glory; and the fewer there were to enjoy a share of the gains of conquest, the more there was for each. But this confiscation of the wealth of others was only renewable as a possibility by fresh conscriptions of the French. They were no longer their own. Glory and pleasure were possible only at the price of enslavement. To one imperial will, a soldier-sovereign, the master of all institutions, France was subjected, and true manliness decayed among its people. The cry of France had been for liberty, Napoleon answered it by a despotism of irresponsible power. Independence, personal or political, was impossible. Alcæus had sung twenty-five centuries before, "Men and the minds of men constitute a state," but Bonaparte, more tyrannously than Louis XIV., asserted *L'ètât, c'est moi.* He claimed to be the master, not the servant, of society. Napoleonism is not yet dead. Many believe in the imperialism of one man. The countervailing imperialism is that of the state as the representative of all, carrying out the behests of all, for behoof of all, through institutions founded on a constitution whose principles are defined and just, and the basis of which is, "right is might." To constitutionalism Napoleonism has succumbed among all the modern confederations of civilization. The imperialism of the sword must be exchanged for the nobler imperialism of commerce, industry, education, and religion—the empire of righteousness, freedom, and peace.

GEOGRAPHY.—CHAPTER XVI.

GREAT BRITAIN—SCOTLAND.

1. *Superficial Features.*—Scotland is divided into two sections by the Grampians, a range of mountains which traverses the whole breadth of the country, from Fort-William to Aberdeen. The northern section is subdivided into two parts by Glenmore, which, passing through several long lochs, forms the line of the Caledonian Canal, and stretches from Fort-William to Inverness. The southern section is also divided by a valley, which, stretching from the Frith of Clyde to the Frith of Forth, forms on the north Central Scotland, and on the south of this boundary the south of Scotland.

To the north-west of Glenmore (the "Great Glen") there is a very extensive plain, varying from 500 to 1500 feet above the level of the sea, and consisting, in general, of barren rocks and mountain masses. Its north and west extremities terminate in abrupt declivities on the sea-coast; but on the east and north-east side, towards the friths of Dornoch, Cromarty, and Moray, the plain becomes, in most parts, lower and more cultivable. The surface of this district, cut by many long, deep, and narrow valleys, in which the inhabitants are few and thinly scattered, produces only pasturage.

The district between Glenmore and the Grampians is divided into two parts by the Cairngorm Mountains. The western section is a plain of an irregular and hilly surface, mostly heath and pasture land. It comprehends the upper districts of the principal rivers. The north-eastern section, though in many parts hilly—except towards the sea-coast—presents a tolerably fertile and well-cultivated country all over the lowlands of Aberdeen, Banff, and Elgin shires.

The western portion of Central Scotland commences on the south side of the Grampians, is generally sterile, much intersected by lochs and arms of the sea, and abounds in wild and picturesque scenery. The eastern portion of this region discloses, among the mountains, valleys of considerable fertility, and stretches out into a level, rich, beautifully cultivated country, comprehending the fertile plain of Strathmore, 80 miles long, from Stirling to Stonehaven, and the plains of Fife, Kinross, and Clackmannan.

Southern Scotland, although in many parts hilly and even mountainous, wants the rugged barrenness of the north. Most of the hills afford pasture for sheep, while many extensive plains and valleys are rich and well cultivated.

2. *Climate.*—The climate, though variable and severe, is on the whole mild and salubrious. The western side is moist and humid, being exposed to heavy rains from the Atlantic. The eastern coast, though drier, suffers from cold east winds and fogs from the German Ocean. The mean annual temperature averages about $46\frac{1}{2}°$ Fahr.

3. *Mountains.*—The chief mountain ranges and groups are:

(1) *North of Caledonian Canal.*

	Feet.
Ben Wyvis (Ross-shire),	3429
Ben Attow "	4000
Ben More "	3657
Ben More (Mull),	3178
Cuchullin (Skye),	3220
Hecla (South Uist),	2600
Sunneval (Lewis),	2700
Mount Roeness (Shetland),	1500

(2) *The Grampian Range.*

Ben Macdhui (Aberdeenshire),	4296
Ben Nevis (Inverness-shire),	4406
Ben Lawers (Perthshire),	3945
Ben Lomond (Stirlingshire),	3192
Cairngorm (Aberdeenshire),	3900
Cairntoul "	4240
Lochnagar "	3786
Mount Keen "	3126

(3) *The Central or Lowland Group.*

Sidlaw Hills (Perthshire and Forfarshire),	1406
Ochills, Ben Clach (Clackmannanshire),	2359
Pentland Hills (Edinburghshire and Lanarkshire),	1878
Lammermuir Hills (Haddingtonshire),	2136
Misty Law (Renfrewshire),	1558
Campsie (between the Forth and the Clyde),	1220

(4) *The Cheviots (with the Southern Highlands).*

	Feet.
The Lowthers (Lanarkshire),	3150
Queensberry Hill (Dumfriesshire),	2140
Hart Fell (Dumfriesshire),	2651
Ettrick Pen (Selkirkshire),	2258
Cheviot (between Roxburghshire and Northumberland),	2676
Cross Fell (between Roxburghshire and Cumberland),	2901

4. *Plains.*—Between the mountain ranges there are many valleys, called carses, straths, haughs, and dales, under excellent cultivation. The chief of these are Strathmore, lying between the Grampian and the Ochill hills, and stretching through Perth, Forfar, and Kincardine shires; the Carse of Gowrie, on the north of the Tay; Strathearn, extending along the course of the Earn to the Tay; the Carse of Stirling and Falkirk, in the valley of the Forth; the Howe of Fife, lying along the Eden; Clydesdale; the Merse of Berwick; and the Howe of Buchan, N.E. of Aberdeenshire.

5. *Lakes or Lochs.*—The lochs—for which Scotland is celebrated, and which add so much to its picturesque scenery—are situated chiefly in the north-western or Highland region. The principal lochs in the different regions are:—

(1) *In the North-western or Highland Region.*

Between Dumbartonshire and Stirlingshire—Loch Lomond, largest lake in Britain; studded with more than thirty islands; has beautiful scenery.

In Argyleshire—Loch Awe, 30 miles long, 1 to 2 miles broad.

In Inverness-shire—Loch Ness, $20\frac{1}{2}$ miles long; Caledonian Canal passes through it. Loch Laggan, 7 miles long. Loch Arkaig, 8 miles long, and Loch Quoich, 5 miles long, both noted for wild, rugged scenery.

In Ross-shire—Loch Maree, 18 miles long by $1\frac{1}{2}$ broad.

In Sutherlandshire—Loch Shin, 17 miles long, 1 to 2 miles broad. Loch Naver and Loch Hope.

In Perthshire—Loch Katrine, 8 miles long by 1 broad; amid the picturesque scenery of the Trossachs. Loch Earn, 7 miles long. Loch Tay, beautiful loch, 15 miles long, 1 to 2 miles broad. Loch Rannoch, 10 miles long, Loch Tummel, and Loch Garry, on the Tay. Partly in Perthshire—Loch Ericht.

(2) *In the Southern Region.*

In Kirkcudbrightshire—Loch Ken, into which the river Ken flows.

In Wigtownshire—Loch Cree.

In Ayrshire—Loch Doon, small; source of river Doon.

In Selkirkshire—St. Mary's Loch, a beautiful lake, 4 miles long.

Loch Leven, in Kinross-shire, is drained by the river Leven into Largo Bay. It contains four islands, on one of which are the ruins of Loch Leven Castle, in which Queen Mary was kept prisoner (1568).

Many indentations of the sea, particularly on the west coast, are denominated lochs—*e.g.* Loch Long, Loch Fyne, Loch Etive, Loch Linnhe, &c.

6.—*Bays, Gulfs, and Straits.*—There are a great many intricate bays, gulfs or friths, and straits on all sides of the kingdom, owing to the numerous indentations of the sea and the number of islands on the north and west coasts, viz.:—

The Pentland Frith—between Caithness and the Orkneys.

Dornoch Frith—a large expanse between Sutherland and Ross.

Cromarty Frith—between Ross and Cromarty; a splendid basin.

Moray Frith—between Ross and Inverness and Nairn and Moray.

Frith of Tay—between Fife and Forfar and Perth.

Frith of Forth—between Fife and the Lothians, running inland for 50 miles; navigable to Alloa, and containing numerous harbours, giving shelter from the storms of the German Ocean.

Solway Frith—separating Dumfries and Kirkcudbright from Cumberland.

Wigtown Bay—between Kirkcudbright and Wigtown.

Luce Bay—in the S., and Loch Ryan, in the N.W. of Wigtownshire.

Frith of Clyde—separating Ayr and Renfrew from Bute, Argyle, and Dumbarton; an important and beautiful frith, containing several picturesque lochs; navigable for large vessels to Glasgow.

Loch Long—between Dumbarton and Argyle.

Loch Fyne—in the S., and Loch Etive and Loch Linnhe, in the N.W. of Argyle.

Sound of Jura—between Argyle and the island of Jura; and Sound of Mull, between Argyle and the island of Mull.

Loch Broom—in the N.W. of Ross.

Minch—separating the mainland and the Isle of Skye from Lewis.

7. *Rivers.*—From many of the fresh-water lochs numerous rivers, but few of magnitude, proceed. Most of them descend from rugged and precipitous mountains, are rapid in their course, cut deep channels in their path, and, with few exceptions, are of no use for internal navigation. The following are the principal rivers :—

Name and Direction.	Length in Miles.	Counties and Chief Towns.
Findhorn, N.E. . .	80	Inverness and Nairn ; Forres.
Spey, N.E. . . .	85	Inverness and Elgin ; Fochabers.
Deveron, N.E. . .	40	Aberdeen and Banff; Huntly, Turriff, Banff.
Don, E.	60	Aberdeen ; Inverury, Old Aberdeen.
Dee (north), E.. .	80	Aberdeen; Aberdeen, Banchory, Ballater.
North Esk, E.S.E.	30	Forfar.
South Esk, E. . .	40	Forfar ; Montrose, Brechin.
Tay, E.S.E. . . .	150	Perth ; Perth, Dunkeld.
Earn, E.	40	Perth ; Crieff, Bridge of Earn.
Forth, E. . . .	115	Perth and Stirling ; Stirling, Alloa.
Clyde, W.N.W. .	100	Lanark, Dumbarton, and Renfrew ; Glasgow, Renfrew, Dumbarton.
Tweed, E.N.E. . .	100	Peebles, Selkirk, and Berwick; Coldstream, Melrose.
Teviot, N.E. . .	35	Roxburgh ; Hawick.
Nith, S.E. . . .	60	Dumfries ; Dumfries.
Dee (south), S.. .	60	Kirkcudbright ; Kirkcudbright.

The only navigable rivers are the Tay, to Perth; the Forth, to Stirling; and the Clyde, to Glasgow.

8. *Capes.*—Capes are equally numerous—*e.g.*

(1) *On the East Coast.*

Dunnet Head, the most northern point of the mainland, and Duncansbay Head—in Caithness.
Tarbet Ness (running northwards)—in Cromarty.
Troup Head—in Banff.
Kinnaird's Head and Buchan Ness—in Aberdeen.
Fife Ness—in Fife.
St. Abb's Head—in Berwick.

(2) *On the South Coast.*

Southerness—in Kirkcudbright.
Barrow Head and Mull of Galloway—in Wigtownshire.

(3) *On the West Coast.*

Corsill Point—in Wigtownshire.
Mull of Cantyre, Mull of Oe, Point of Rinns, and Point of Ardnamurchan (the most westerly point of mainland of Scotland)—in Argyle.
Butt of Lewis—in the N. of Lewis.
Barra Head—S. point of Hebrides.
Aird Point—in Skye.
Cape Wrath—in Sutherland.

9. *Islands of Scotland.*—Its islands form nearly one-sixth of the area of Scotland, and are one of its most characteristic features. They are, for the most part, hilly, rugged, sterile, and weather-beaten rocks.

On the east coast there are only a few unimportant islands, principally in the Frith of Forth :—

Inchcolm—near Aberdour, contains ruins of a monastery.

Inchkeith—Leith (fortified), with an elegant lighthouse.

The Isle of May—with a lighthouse at entrance of frith.

The Bass—almost inaccessible, formerly a state-prison.

The Bell Rock—12 miles south-east of Arbroath, covered at high water; has a lighthouse 115 feet high.

On the west coast the islands may be most conveniently arranged into three great groups:—

(1) *In the Frith of Clyde.*

Bute—18 miles long, 5 broad; except towards the N., where it is high and rugged, noted for picturesque beauty and mild climate.

Arran—large oval island, 18 miles long, 12 broad; noted for the remarkable geological formation of its rocks.

The two Cumbraes—on the Ayrshire coast.

Ailsa Craig—a rocky islet off the coast of Ayr, 2 miles in circumfererence, and 1098 feet high.

(2) *The Inner Hebrides—(a) Belonging to Inverness-shire—*

Skye—one of the largest of the Western Isles, 46 miles long by 25 broad, remarkable for its lofty cliffs and spar cave.

Raasay—a small hilly island, chiefly used for pasture. It lies between Skye and the mainland of Ross.

Rum—a small bleak and barren island, lying S. of Skye.

Eigg—a small island of diversified aspect, and bounded by rugged rocks.

(*b*) *Belonging to Argyleshire.*

Mull—25 miles long by 20 broad; a stormy, rainy, dreary island. On it black cattle and sheep are reared; its agricultural produce is inconsiderable.

Isla—south-west of Jura, 24 miles long, 18 broad; is in general mountainous, but has much level cultivated land.

Jura—north-east of Isla; rugged and barren. Of its three conical mountains (" Paps of Jura "), the highest is 2470 feet.

Iona or Icolmkill—a very small island of a rugged and mountainous aspect, west of Mull. An early home of learning and religion, founded by St. Columba here in 573. The ruins of a monastery still remain. Here were interred forty-eight Scottish, four Irish, and eight Norwegian kings.

Staffa—the greatest natural curiosity of Europe, if not of the world, a small island on the west of Mull, celebrated for its basaltic columns and caverns. Fingal's cave is 66 feet high, 42 wide, and 227 feet long, presenting a most beautiful and magnificent scene.

Tiree—small, flat, and fertile, is one of the most valuable of the Hebrides. It supplies beautiful marble.

(3) *The Outer Hebrides—a high range,* 140 *miles long.*

The Hebrides or Western Isles (anciently Ebudes), consist of 200 islands, of which 70 are inhabited. They are all rugged and barren, cold and moory. The principal islands in the range are:—

(1) Lewis and Harris—really forming one long island. Lewis is in some parts very hilly; in others, low, mossy, or covered with lakes. The chief arable land is on the shore, or near Stornoway, the only town of the Outer Hebrides. The soil and climate combine to keep Lewis wretched and desolate. Harris, the southern portion, is mountainous, steep, wild, and, with the exception of a few small patches here and there, uncultivated.

(2) North Uist, Benbecula, South Uist, Barra, &c. With the exception of Barra, which is wonderfully fertile, these are almost all covered with rocks, lakes, or bogs, present a wild and dreary appearance, and produce a very scanty vegetation.

On the ocean north of Scotland there are two distinct groups:

(1) The Orkney Islands (Orcades), sixty-seven in number —of which twenty-nine, tolerably fertile, are inhabited— separated from the mainland by the Pentland Frith. They are destitute of trees. Their appearance is inviting. Sanda is called the granary of the Orkneys.

(2) The Shetland or Zetland Isles, a group 48 miles N.E. of the Orkneys. There are upwards of 100; thirty-two of them are inhabited, the others are small verdant isles, on which cattle and sheep are pastured, or are sterile masses of rock.

The largest is called the Mainland. It is 55 miles long, from 3 to 10, and in one part 24 miles broad. Yell is the second, and Unst the third in size; the others are all small. Shetland is famous for its extensive cod fishery, its breed of small ponies, and its fine wool.

From their high latitude, daylight at midsummer never totally disappears; in winter the nights are proportionally long and dreary. In December the sun is above the horizon 5 hours and 20 minutes.

Scotland is divided into thirty-three counties or shires, which are as follows:—

(1) *Northern Counties, Eleven.*

County and Area (in square miles).	Distinguishing Features—County and Chief Towns.
Orkney and Shetland (927),	Formed by the islands bearing these names. Kirkwall in Orkney, Lerwick in Shetland.
Caithness (685), . .	Mountainous; great herring fishery on coast. Wick, a seaport; seat of a great herring fishery.

County and Area (in square miles).	Distinguishing Features—County and Chief Towns.
Sutherland (2027),	Mountainous; deeply indented by seas; gneiss prevails. Dornoch, royal burgh, on Dornoch Frith.
Ross and Cromarty (3129),	Mountainous, with some fertile tracts, the former inclosing many detached portions of the latter. Cromarty, finely situated on south shore of frith of same name; manufactures sailcloth, sacking, cordage, &c.; birthplace of Hugh Miller, geologist and *litterateur*.
Inverness (4088),	Largest county; extends entirely across the country; includes Skye, the Outer Hebrides, &c., except the north of Lewis. Inverness, near where the river Ness joins the Moray Frith; capital of the Highlands, delightfully situated; 5 miles N.E. the battle of Culloden was fought in 1746.
Nairn (178),	Small but fertile county, south of the Moray Frith. Nairn, at mouth of the Nairn, on Moray Frith.
Elgin or Moray (475),	Except the upper mountainous districts, fertile. Elgin, 5 miles from sea; ancient cathedral, one of the most magnificent ruins in Scotland.
Banff (640),	Greater part mountainous (Cairngorm, 4095 feet); well watered. Banff, at mouth of Deveron, a seaport, castle.
Aberdeen (1955),	Comprises Mar, Garioch, Formartin, and Buchan, the first mountainous, the others fertile. Aberdeen, a seaport, extensive trade and manufactures; built of granite, seat of a university; capital of the north of Scotland. Peterhead, a seaport, fine harbour, large fisheries' trade.
Kincardine or Mearns (383),	Surface varied. "How of Mearns" fertile. Stonehaven, good harbour, considerable trade. Dunottar Castle (in ruins) 150 feet above sea. Laurencekirk, birthplace of James Beattie.

(2) *Middle Counties, Nine.*

County and Area (in square miles).	Distinguishing Features—County and Chief Towns.
Forfar or Angus (875),	Fertile, noted for its breed of cattle. Dundee, on Frith of Tay, a large and commodious seaport, great shipping trade, extensive linen manufactures, excellent technical colleges and schools. Arbroath, seaport, considerable trade; ruins of an ancient abbey. Montrose, flourishing seaport at mouth of South Esk. Forfar, agricultural centre in valley of Strathmore. Brechin, manufacturing town, once an episcopal see.
Perth (2527),	Comprising Monteith, Breadalbane, Rannoch, Athole, Strathearn, Stormount, Balquhidder, and the fertile Carse of Gowrie. Perth, on the Tay, an ancient city, delightfully situated amid beautiful scenery. Scone, where the kings of Scotland used to be crowned.
Fife (492),	Beautiful, varied, and fertile county. Dunfermline, west of Fife, ruins of its ancient abbey and royal palace; linen manufactures. St. Andrews, a very ancient city, the seat of a university, once the ecclesiastical capital of Scotland; ruins of ancient castle, chapel of St. Regulus, and noble cathedral. Kirkcaldy, on Frith of Forth, seaport, carries on considerable trade; birthplace of Adam Smith.
Kinross (72),	Small inland county, west of Fife. Kinross, on west of Lochleven (where Mary Queen of Scots was imprisoned), manufactures shawls, plaids, cottons.
Clackmannan (47),	Very small, on north side of the Forth. Alloa, fine town, north of Forth, brisk trade. Clackmannan, 150 feet above Forth; Dollar.
Dumbarton (241),	In the West of Scotland, varied surface. Dumbarton, on Clyde, ancient strong castle, on a precipitous rock. Helensburgh; Renton.
Stirling (447),	Fertile, lying between the Forth and Clyde. Stirling, on the Forth, commands a noble prospect; ancient castle, was a favourite residence of the Scottish kings. Falkirk, has large cattle-markets, called *trysts*; Carron ironworks. Bannockburn, thriving manufacturing village, scene of battle between Robert Bruce and Edward II. (24th June, 1314).
Argyle (3213),	Much indented by arms of the sea; romantic hill and lake scenery. Campbeltown, a seaport, at the head of a beautiful bay. Inverary, seaport west of Lochfyne; seat of the Duke of Argyle. Oban, summer and health resort.
Bute (217),	Comprising the islands of Bute, Arran, Inchmarnock, and the Cumbraes; Rothesay, north-east, on fine bay, sea-bathing and health resort. Brodick, magnificent scenery.

(3) *Southern Counties, Thirteen.*

County and Area (in square miles).	Distinguishing Features—County and Chief Towns.
Haddington or East Lothian (270),	Very fertile, agriculture in great perfection. Haddington-on-Tyne, corn and wool markets; old collegiate abbey church; birthplace of Alexander II. and John Knox. Dunbar, seaport, shipbuilding, castle. North Berwick, summer quarters.
Edinburgh or Midlothian (362),	Metropolitan county, very fertile and well cultivated, rich in coal, iron, and freestone. Edinburgh, metropolis, seat of the courts of law, and of a long-celebrated university, is a beautiful city, perhaps unequalled in Europe. Leith, on Frith of Forth, the seaport of Edinburgh, $1\frac{1}{2}$ miles distant, important shipping trade. Dalkeith, 6 miles south of Edinburgh, beautiful town; Dalkeith Palace, the seat of the Duke of Buccleuch, is near.
Linlithgow or West Lothian (120),	Fertile, lies along south side of Frith of Forth. Linlithgow, noted for the ruins of the noble palace in which Queen Mary was born.
Berwick (460),	Fertile and well cultivated, lies in the south-east of Scotland; traversed by Lammermuirs. Duns, market-town. Coldstream, Eyemouth, seaport.
Roxburgh (665),	A border county, fertile, well-watered. Hawick, a thriving manufacturing town. Melrose, on the Tweed, noted for its magnificent abbey, founded by David I., in 1136; the ruins are the most entire and beautiful in Scotland. Kelso, at junction of Tweed and Teviot, beautifully situated town, noted for the ruins of a magnificent abbey.
Selkirk (257),	Pastoral uplands, arable along rivers Gala, Ettrick, Yarrow. Galashiels, on the Gala, noted for its woollen manufactures. Selkirk, hosiery, &c.
Peebles or Tweeddale (354),	Agricultural and pastoral, lying along both sides of upper course of the Tweed. Peebles, anciently a Scottish mint-town; weekly market, archery centre.
Lanark or Clydesdale (881),	Divided into Upper, Middle, and Lower Wards, one of the most important counties. Glasgow, on the Clyde, the first city in Scotland for population, manufactures, commerce, and wealth, extensive cotton and other manufactures, a great trade with America and the West Indies; a flourishing university. Lanark, near it are the celebrated Falls of Clyde. Hamilton, near junction of Avon and Clyde, Duke of Hamilton's splendid palace. Airdrie, thriving town, centre of coal and iron works.
Kirkcudbright (897),	Maritime county, surface varied, pastoral. Kirkcudbright, on Dee, excellent harbour.
Wigtown (485),	Maritime county, undulating, south-west angle of Scotland. Wigtown, royal burgh, considerable trade; seaport.

County and Area (in square miles).	Distinguishing Features—County and Chief Towns.
Renfrew (245), . .	Lies along Clyde, seat of great trade and manufacures. Paisley, manufactures silk, cotton, and fancy goods, &c. Greenock, at mouth of Clyde, the principal seaport of Scotland, extensive trade; the birthplace of James Watt (1736).
Ayrshire (1128), . .	On south-west coast, comprises Carrick, Kyle, and Cunningham, noted for agriculture, cattle, and dairies. Ayr, noted for associations with the poet Burns. Kilmarnock, the seat of considerable woollen manufactures. Ardrossan and Girvan, seaports, considerable trade in coals, &c.
Dumfries (1062), . .	Comprises Eskdale, Annandale, and Nithsdale, a fertile and important agricultural county. Dumfries, on Nith (9 miles from Solway Frith), a handsome town, where Burns died; Lincluden Abbey. Ecclefechan, birthplace of Carlyle. Moffat, mineral springs, health resort.

10. *Vegetable Productions*—These are specifically the same as in England, but from the higher latitude and general altitude of the land, they partake more of an alpine character. Many of the forest trees of England cannot withstand the severity of a Highland winter, but in the Lowlands they arrive at the usual perfection. The native pine and birch alone arrive at maturity. In Scotland, we reach the limit at which timber trees grow. As a large extent of surface is occupied by sterile mountains, elevated moors, rocks, bogs, and morasses, the cultivable lands are limited. All the common grains are cultivated in the Lowlands; but oats, and a coarse variety of barley, are the main grain crops grown in the upper districts of the Highlands and Islands.

11. *Animals.*—The animals of Scotland are specifically the same as in England, but present characteristic differences.

The *Domesticated Quadrupeds* are smaller in size. Several breeds of animals are peculiar to Scotland—*e.g.* the Clydesdale, Galloway, and Shetland horse; the Aberdeenshire, Ayr, Fife, Angus, and West Highland ox; the Cheviot sheep of the south, and the blackfaced hardy wether of the north. The stag, the roe, and the wild cat are the wild animals peculiar to the Highland mountains.

Birds.—Grouse, partridge, woodcock, blackcock, ptarmigan, and capercailzie are abundant in several localities.

Fish.—The rivers of Scotland produce salmon, trout, pike, and perch, but there are fewer species of fresh-water fish in Scottish than in English waters.

12. *Industries*—The cotton manufacture, extensively carried on in Lanark and Renfrew, with Glasgow and Paisley as its centres, and also in Ayr, Perth, Aberdeen, &c. Paper-making is conducted on a large scale in Midlothian, Fife, and Aberdeen. Iron and steel manufacture is carried on in the counties of Lanark, Stirling, and Ayr; engine-building, machinery, and shipbuilding are carried on extensively at Glasgow, Dumbarton, Aberdeen, Arbroath, &c. Type-founding, printing, and publishing are conducted on a large scale in Edinburgh and Glasgow. Leather, chemical products, glass-wares, soap, &c., manufactures, brewing, distilling, &c., employ considerable labour. The chief mineral productions of the country are:—Limestone and clay, for tiles and bricks, are found in almost every county. Granite of excellent quality is wrought at Aberdeen, Peterhead, and Kirkcudbright. Marble is worked at Assynt, serpentine at Portsoy, slate at Ballachulish, in Aberdeenshire, &c. Building stones of first-rate quality are found in Fife, Midlothian, &c. Coal occurs in Fife, Midlothian, Linlithgow, Stirling, Lanark, and Ayr. Alum is procured from the coal-shales near Campsie and Hurlet; ironstone in most of these coal-fields, but chiefly at Lanark. Lead is in a great measure a product of the Lowther Hills, and silver is extracted in small quantities from the lead. Strontian, as a carbonate, is found in Argyleshire. Precious stones, as garnet, rock-crystal, cairngorm, agate, &c., are abundant.

Extensive and flourishing as the various manufactures have become, the commerce of Scotland has more than kept pace with them. Internal communication is greatly facilitated by railways, whose numerous branches, in addition to excellent macadamized roads, canals, &c., vastly contribute to the development and ready transfer of all the mineral resources and much of the agricultural and manufacturing produce of the country.

THE FRENCH LANGUAGE.—CHAPTER XVI.

SYNTAX OF THE SUBJUNCTIVE—CORRESPONDENCE—PRACTICAL HINTS FOR FUTURE STUDY—CONCLUSION.

THE SYNTAX OF THE SUBJUNCTIVE MOOD.

THE indicative mood is used to express a thing as a fact, while the subjunctive represents it as a conception of the mind. As it entirely depends on the idea intended to be expressed, whether certainty or uncertainty, informing or ordering, be implied, and as it frequently occurs that the same verbs have very different implications, one verb sometimes governs the indicative and sometimes the subjunctive, according to the specific signification in which it is used; as *Savez-vous qu'il est à Paris?* Do you know that he is in Paris? *Savez-vous qu'il soit à Paris?* Do you know if he is in Paris? Thus *entendre*, to hear, *prétendre*, to affirm, *dire*, to tell, *écrire*, to write, require the indicative; but *entendre*, to intend, to wish, *prétendre*, to insist upon, *dire*, to order, *écrire*, to order (in writing), require the subjunctive: *e.g.*

Je l'entends qui fait du bruit,	*I hear him making a noise.*
J'entends que vous fassiez cela,	*I will have you do that.*
Il prétend qu'il a fait son devoir,	*He pretends he has done his duty.*
Il prétend que nous fassions notre devoir,	*He will have us do our duty.*

Hence the subjunctive mood is used in subordinate sentences after verbs and conjunctions expressing or implying—

(1) A wish, command, or necessity. Therefore the imperative, followed by *que*, implying request or command, generally requires the next verb in the subjunctive.

(2) Any doubt, ignorance, or uncertainty—as in verbs of saying and thinking used interrogatively or negatively.

(3) Some affection of the mind; as joy, sorrow, disgust, regret, fear, surprise, &c.

(4) A purpose, result, concession, or supposition.

The following are a few of the more common verbs in the foregoing classes—viz.

Douter,	*to doubt.*	Exiger,	*to require.*
Craindre,	*to fear.*	Nier,	*to deny.*
Avoir peur,	*to be afraid.*	Souhaiter,	*to wish.*
Commander,	*to command.*	Etre charmé,	*to be delighted.*
Défendre,	*to forbid.*	Etre fâché,	*to be sorry.*

Impersonals like the following require the subjunctive:—

Il faut,	*it is necessary.*	Il est juste,	*it is fair, just.*
Il importe,	*it matters.*	Il est injuste,	*it is unfair, unjust.*
Il convient,	*it suits.*	Il suffit,	*it is sufficient.*
Il est fâcheux,	*it is vexatious.*	Il semble,	*it seems.*

Il importe que vous soyez attentifs, *it is necessary that you should be attentive.*

But impersonals which express a certainty, as *il est certain, sûr, clair, évident, vrai*, &c.; *il arrive*, it happens; *il résulte, il s'ensuit*, it follows; *il paraît*, it appears, &c., take the indicative, unless when used interrogatively or negatively; as *Il arrive souvent qu'on est trompé.*

The subjunctive mood is used after the relative pronouns *qui, que, dont, lequel, laquelle, on*, when they follow—

(1) A superlative; as *Vous êtes l'homme le plus savant que je connaisse*, You are the most learned man I know.

(2) The indefinite pronouns *quelque*, whatever; *qui que ce soit*, whoever; *personne*, nobody; *pas un*, not one; *rien*, nothing; as *Je ne connais personne qui soit aussi fier que vous*, I know nobody so proud as you.

(3) Ordinal numbers; as *Vous êtes le premier homme que j'aie rencontré aujourd'hui*, You are the first man I have met to-day.

(4) *Le seul, l'unique, le dernier;* as *C'est le seul homme que je puisse consulter*, He is the only man I can consult.

(5) *Pas un, aucun, rien, peu*, when these words are preceded by *il y a, il n'y a, il est, il n'est*, &c.; as *Il n'y a rien qui rafraîchisse l'âme comme une bonne action*, Nothing refreshes the soul so much as a good action.

Interrogations and negations require the subjunctive, because they naturally imply a doubt; as

Je crois qu'il est honnête homme,	*I believe that he is an honest man*
Il est vrai que vous êtes malade,	*It is true that you are ill.*
Il n'est pas vrai que vous soyez malade!	*It is not true that you are ill!*
Croyez-vous qu'il soit honnête homme?	*Do you believe that he is an honest man?*
Est-il vrai que vous soyez malade?	*Is it true that you are ill?*

Unless the speaker has really no doubt of the matter mentioned in the question, or when the interrogation is merely an oratorical turn of phrase, which affirms more strongly, in which cases the indicative is used; as

Vous ai-je dit que mon père est arrivé?	*Have I told you that my father has come?*
Oubliez-vous donc qu'il est votre père?	*Do you forget, then, that he is your father?*

If the two clauses of a sentence are joined by any of the conjunctions given in Class II., p. 882, use the subjunctive after them; as *Prêtez-lui votre livre afin qu'il puisse écrire son thème*, Lend him your book that he may write out his exercise. (See other examples, p. 882.)

The subjunctive is used when in exclamative sentences the indicative is omitted by ellipsis; as *Que je meure si je ne me venge pas!* May I die if I do not avenge myself!

The tense of a verb in the subjunctive mood must be brought into exact concord with the tense of the antecedent verb of the principal clause, *i.e.* the one on which it depends.

The present, the future, and the imperative are followed by the present subjunctive to express a simultaneous action, and by the perfect subjunctive to express an accomplished action:

Nous regrettons
Nous regretterons } qu'il soit malade, *or* qu'il ait été malade.
Ne regrettez pas

The imperfect, the perfect, the indefinite, the pluperfect, the anterior, and the conditional are followed by the imperfect subjunctive for a simultaneous action, and by the pluperfect subjunctive for an accomplished action; as

Nous regrettions, nous regrettâmes
Nous avons (avions, eûmes) regretté } qu'il fût malade, qu'il eût été malade.
Nous regretterions
Nous aurions regretté

The present subjunctive is, however, often used after the indefinite; as *Il est parti, quoiqu'il pleuve*, He has gone out although it rains.

French writers often use the infinitive instead of the subjunctive, when the person which is to be the agent of the next verb is with sufficient exactness pointed out, either by a dative coming before or by the context; as

	instead of	
J'espère pouvoir revenir demain		J'espère que je pourrai revenir demain.
I hope to be able to return to-morrow.		*I hope that I may be able to return to-morrow.*
Je crains de tomber malade		Je crains que je ne tombe malade
I am afraid of falling ill.		*I am afraid lest I fall ill.*
Je crois l'entendre		Je crois que je l'entends.
I believe I hear him.		*I believe that I hear him.*
Dites-lui de venir		Dites-lui qu'il vienne.
Tell him to come.		*Tell him that he may come.*

HINTS ON FRENCH LETTER-WRITING.

The common saying that the law of letter-writing is—to write as you would speak, is quite correct in so far as it means that a simple and unaffected style ought in general to be used. But in most cases—because writing implies time to choose and arrange both ideas and expressions—it is the custom to expect that a letter shall be somewhat more precise in statement, and rather more agreeably turned, than conversation usually is. Too much art, however, is as unsuitable as too much easy-going familiarity. A letter properly written—both in what is said and in the manner of saying it—should differ according to the relative position of writer and recipient. Respect, duty, friendship, superiority, and inferiority have each a special language, and good sense, good feeling and tact, as well as a knowledge of expression, are required to hit the mark in each case happily.

In *business* letters, wit and playfulness are out of place. They imperiously exact clearness and completeness. Begin without preamble or circumlocution, state your business—saying exactly what requires to be said—and no more. Let each distinct item be explicitly expressed, and pass from one to another without any formal phraseology. In letters of *solicitation*—applications for situations, favours, orders, &c.—the tone should be respectful in proportion to the position of the person addressed and the object aimed at in the letter. Letters of *recommendation* should be cordial yet guarded, and explicit yet neatly turned. Letters of *advice* ought to be kindly, plain, reasonable, full of good feeling, free from dictatorial abruptness or language likely to wound. When a letter of *censure* requires to be written, be cautious and prudent. Be as polite as possible; do not embitter your phrases unnecessarily, carefully avoid exaggerating what is complained of, and soften the words of blame as far as is consistent with the object of the communication, while frank and natural in explaining the cause of displeasure. *Consolatory* letters ought to be serious, soothing, simple, grave, encouraging, and while sad yet hopeful. In letters of *friendship*, familiarity, wit, and even banter are permissible, but these ought neither to be rude nor rough. Freedom of style and humour of narration are quite in place. In regard to familiar, friendly, or polite letters, letters on family affairs or affairs of the heart, no one can give advice, except it be (1) never use a "universal letter-writer," and (2) mind the old saying—"Look into thine own heart and write."

The French place the *date* of their letters indifferently at the beginning or the end. In business it is the rule to place it at the right-hand corner of the top of the letter, just below the address of the sender.

At or about an eighth part of the page from the top write on a single line the word *Monsieur*, *Madame*, or *Mademoiselle* (*Sire* to kings, *Monseigneur* to princes and church dignitaries, from bishops upwards—all according to their rank). Begin the letter just a little nearer the left side than the middle of the page. If it is necessary to turn over a page, the second (*i.e.* the reverse) is begun nearly at where the title was written on the previous page, though with equals and friends it is not necessary thus *donner la ligne*.

Avoid, in letters to superiors, the use of the second person, and use instead some suitable, periphrastic form; *e.g. Monsieur, &c., Votre Excellence, Votre Grandeur, Votre Eminence, Votre Altesse, Votre Majesté, Monsieur le Président, &c.*

At the *close* of a letter, as if beginning a new paragraph, (1) write *J'ai l'honneur d'être* (or *Je suis*), *avec respect* (*estime, consideration, &c.*); (2) repeat the title used at the commencement, and, as formerly, on a single line; (3) on a new line, nearer the right-hand corner, put the words *Votre très-humble et très-obéissant serviteur;* and (4) affix your signature, taking care, if you intend to place the date at the end, that you have space to write it distinctly in the left-hand corner. If, however, the letter is to a friend, an equal, or an inferior the paragraph phrase may differ; *e.g. Je suis, avec les sentiments les plus distinguées* (or *avec attachment, &c.*), *Votre* (as before)—the form obviously depending on the relations existing between the persons. Politeness requires that in writing to a superior no compliments should be sent to any third party or any *postscript* be added.

The title put on the *superscription* or *address* should correspond with that *mis en vedette* at the commencement of the letter, and the formula by which the person has been referred to in the body of the letter.

As business letters are most likely to require the care of the majority of students, we give a few specimen forms for beginning and ending these:—

Londres, 92 Cannon St.,
Le 11 Janvier, 1890.

Monsieur Emile Mongeot.
Monsieur,

J'ai l'honneur de vous annoncer que, &c. . . .

Je vous prie de disposer librement de mes services ici.
Je suis, avec une haute considération,

Monsieur,

Votre très-humble et très-obéissant serviteur,

JOHN GARDINER.

Liverpool, 13 N. Quay,
le 2 Octobre, 1890.

Monsieur,

Nous avons le plaisir de vous accuser réception de votre lettre du 10 du passé, &c. . . .

Dans l'attente de vos nouvelles, nous vous saluons avec une parfaite estime.

Monsieur,

Vos bien dévoués serviteurs et amis,

GUILLAUME DUPORT ET FILS.

Messieurs,

La presente vous sera remise par M. Gustave Kampmann de Paris, agent de l'estimable maison Aug. Boyer et Cie. de la même ville, avec laquelle j'ai eu occasion de faire des affaires considérables, &c. . . .

S'il avait besoin de quelques renseignements, je vous serais infiniment obligé de les lui fournir, et vous serai également reconnaissant de tout autre service que vous pourrez avoir occasion de lui rendre, me confiant, à cet égard, en votre bienviellance accoutumée.

Agréez, Messieurs, mes salutations les plus affectueuses,

EMILE DE BONNECHOSE.

A Messieurs Guillaume Duport et Fils,
Liverpool, 13 N. Quay.

Lyon, le 24 Dec. 1890.

Birmingham, 7 Aston Road,
A. M. E. Sommer, Le 4 March, 1890.

Monsieur,

Nous avons l'honneur de vous adresser ici la signature de notre client M. Pierre Jullien, dont nous vous prions de vouloir bien accueillir les traites jusqu'à concurrence de 200 livres sterling (£200), et sous notre garantie.

Nous avons l'honneur d'être,

Monsieur,

Vos très-humbles et très-obéissants serviteurs,

ROBERTS & THOMSON.

HINTS FOR FUTURE STUDY—CONCLUSION.

The student who has assiduously followed the course of lessons which we have prescribed for him may now really congratulate himself on having reached the end of the most laborious portion of the task undertaken. He should possess so much familiarity with the subject that any further work at the French language should be more of a pleasure than a toil. He should by this time have acquired a fair knowledge of the grammar—including accidence, syntax, pronunciation—and made himself master also of a useful, varied, and pretty extensive vocabulary. He ought to have a good, serviceable knowledge of the forms, and a correct idea of the nature and peculiarities, of the language, as well as a clear perception of the difficulties it presents. His studies will in the future partake less largely of the character of a conscientious but almost blindly confiding "grinding up" of a toilsome daily task. He can, we may fairly assume, criticise the progress he has made in the work to which he set himself, gauge his attainments and the estimated relative importance of each day's work, in reference to the whole task on which he has been engaged, and which we hope he means to pursue.

We have not hesitated to impress on his mind that the acquisition of the French language, like the attainment of all knowledge, is beset with difficulties which only patience and industry can overcome. A correct method of learning, a faithful effort to follow out details, and a good memory to retain the facts which have been taught and studied, help greatly to simplify the work. The acquirement of a practical knowledge of a language, however, is not and cannot be the labour of a few months, but of years; and no true and wise student will treat otherwise than disdainfully those numerous brochures and pamphlets which hold out persuasive promises that by their aid a new language can be acquired in little more time, and with little more work, than is needed to learn a new alphabet. This will appear at once to any reflecting mind. A language, though consisting of words, is not a mere set of counters, one of which can be taken up and replaced by another. Their use is the result of associations and influences, and the constructions into which they fall are the consequences of mental habits which differ in every nation. To employ individual words correctly requires a good memory, aided by a quick judgment, and to construct sentences rightly the student must learn to turn his thoughts into the form which accidence has taught him, and to arrange them in accordance with the settled syntax of the language engaging attention.

There are four distinct stages in studying a language—viz.

1. Ability to read it, which implies (1) a knowledge of the meaning of single words, and (2) an appreciation of their relation to each other when arranged in sentences.

2. Ability to understand it when spoken, which requires (1) aptness of ear to receive sounds; (2) readiness of mind to transform these into words; and (3) capacity to form these words into their equivalents in thought.

3. Ability to speak it, which depends on (1) distinct articulation; (2) command of words; (3) clear notions; and (4) habitual sense of the laws of syntax.

4. Ability to write it, which involves (1) a ready acquaintance with grammar; (2) a knowledge of idioms; and (3) the study of style.

The student ought now not only to be able to acquit himself well in the first stage, but should have laid a solid foundation for progress in the other three stages. The reading of French will not, of course, be quite easy to him even yet, but if he will get any of the tales of Jules Verne, or the novels of Erckmann-Chatrian (say "Waterloo"), and set himself as a daily task the perusal of a few pages, keeping by his side and using his dictionary freely for all unfamiliar words, and referring to the lessons in grammar supplied in this course for the explanation of any sentences the construction of which he may find obscure, he will be surprised to find how soon he will be able to read off the meaning—which ought not now with him to be a word for word translation—of whole sentences and paragraphs, without help save that furnished from his own memory. Most probably before finishing the story the interest will have proved to be so strong and the reading so easy that he may be tempted to use his dictionary even too little, eager rather to make a hasty and random guess at the meaning of words than interrupt his reading by conscientiously looking them up, as he should do, in the dictionary—a duty which as a student he ought never to neglect. If, however, he find the fascination too strong, he ought to pencil the unknown or puzzling words for future reference.

After finishing one book thus, it is well to read another by the same author; for each writer has his own pet vocabulary of words and his own peculiar turns of phrase. In these he is accustomed to express his thoughts; and having got into his way, it is advisable to secure the full profit of the knowledge gained, and see how this explains the fact that the student always finds the first work of each author he reads the most difficult one. Each fresh author has his own vocabulary, idioms, and peculiarities of style, associations, allusions, &c., and at first these new things are troublesome to get acquainted with—though when mastered they possess a charm for us. It is one of the delights of reading thus to find out and feel the special flavour and aroma of an author's style, and to perceive the fine felicities in which the minds of various men set forth their perceptions of facts and their thoughts regarding affairs.

This is the true understanding of a language, when we can compare and contrast the different means by which human speech interprets human thought, and can thus gain an insight into the operations of the mind and the inner influences of life. Thus speech aids the intercourse of minds.

The acquirement of fluency in speaking a language, or readiness in understanding it when spoken, implies of course that the student has the advantage of some one to converse with.

Much can indeed be done to overcome difficulties by reading aloud, with special care and distinctness, to one's self, and more still by one student alternately reading aloud to another, or by reading such dialogues as may be most easily got in books. Much can also be done by the student endeavouring to *think* in French—that is, transfuse his ideas immediately into French—instead of first thinking in his own language and then translating each English sentence into French. Ingenuity may even be exercised by the student's endeavouring to carry on imaginary French conversations with himself, and so acquiring a fluency of utterance by dogged perseverance. But of course all these plans, useful and possible though they are, are only secondary. A *perfect* mastery of the French language as spoken can only be thoroughly and properly acquired by contact and conversation with Frenchmen—men whose minds are "native and endued unto" the associations, phraseology, idioms, and vernacular specialties of the language, not of books, but of everyday life.

The writing of French is the most difficult task of all, though one at first sight would scarcely think so. Many Englishmen can read French, and many of these can, even with considerable aptness, converse in it; but the number who can write it idiomatically, fluently, and correctly is small indeed. To attain to this, the highest pitch of perfection in French writing, a perfect knowledge of spelling, accentuation, accidence, syntax, idioms, and a copious vocabulary are necessary; but besides this, the order and movement of thought and the method of expression also demand the utmost care, that we may be natural, clear, melodious, choice, and elegant in composition; and it is fortunate that in the attainment of these the private effort of the individual and the zealous study on which he engages are the most important means of attaining ultimate and unexceptionable success. Perhaps on this subject these lines by Boileau may be worth reading—

"Sans cesse, en écrivant, variez vos discours.
Un style trop égal et toujours uniforme
En vain brille à nos yeux, il faut qu'il nous endorme.
On lit peu ces auteurs, nés pour nous ennuyer,
Qui toujours sur un ton semblent psalmodier.
Heureux qui dans ses vers sait d'une voix légère
Passer du grave au doux, du plaisant au sévère!
L'ennui naquit un jour de l'uniformité."

The student who desires thoroughly to prepare himself for acquiring such fourfold power over the French language as we have been speaking of, will perceive that it is most essential that he should revise entirely all the French lessons which have been placed before him in this course, devoting his efforts especially to the strengthening of his recollection of the more important paradigms, rules, and explanatory passages, learning those with care which he had previously passed over as uninteresting or tedious, and making frequent endeavours to invent fresh exercises similar to those which have been suggested in various lessons, so as at once to test his knowledge of what he has read and to stimulate his mind to activity in attaining fluency of style and utterance. We would not, however, advise him to begin this course immediately, or to continue it to the exclusion of careful and well-chosen reading of the best French authors. Let him, we would say, at least first read the lessons we have now provided on French literature; and on doing so he will see—as in a small map of a large continent—somewhat of the treat which is in store for him when he begins to apply the knowledge which he has hitherto been painfully acquiring to engage in converse with the highest minds and the most vital thinkers among the French. He will then with fresh zeal renew his old studies—grammar and syntax—in order that he may be able to read in their mother tongue, and with a fuller appreciation of their worth, the writings which make up the literature of perhaps the most cultured, and certainly the most artistic, nation in Europe.

Let it not be forgotten also that France is a country to which access is easy, and that an acquaintance with the language of its inhabitants greatly enhances the comfort of a residence and the delight of a visit to that neighbouring nation. Its social life, its national history, its humours, and the daily occurrences which affect its society and react on Europe are all of high intellectual concern. It is a language in which every thought of value in the world soon finds clear and expository expression. In our own times the importance of the social and commercial relations of that nation and our own has increased vastly. Not only therefore does a knowledge of the French language promise a large addition to our mental culture and intellectual joy, but it provides new interests for our lives and adds to the possibilities of our personal progress both socially and commercially. The scholar, the statesman, the man of business, and even the working man will find his social and individual worth very considerably enhanced, if he adds to the ordinary qualifications of his business or profession a knowledge of that language which, next to his own, is more widely diffused and more generally used in every quarter of the world than any other. A thoughtful consideration of the advantages derivable from the patient and persistent prosecution of his studies ought to intensify the ardour and stimulate the diligence of every student of this course of lessons on the French language.

FRENCH LITERATURE.—CHAPTER I.

SECTION I.—FROM THE EARLIEST TIME TO THE INSTITUTION OF THE FRENCH ACADEMY.

EVEN in an age like ours, inheriting as we do, whatever be our native land, literature so varied, excellent, and voluminous, a student whose reading is confined to one language is necessarily liable to a sort of provincialism of thought. The great cardinal tendencies of races and their interests do not come directly home to him, nor does he acquire that largeness of view and width of sympathy which ripen and quicken the sense of humanity in the spirit. The soul of civilization operating in every land produces intellectual life, a knowledge of which can only be attained by us when we come into the close vital relations of companionship, of feeling, thought, and aspirations—of direct intercourse with the highest and best minds. Not only as a means of attaining possession of truths and facts, but as an agent in developing the power of knowing and appreciating these—not as embodied to us in representative phrases, but as realized by us in actual thought, the study of another language than our own is beneficial. Hence, when a student's knowledge of a language in its grammar and lexicon is sufficiently far advanced, and he can trace the structure of a sentence so as to know its elements and understand its function, it is advisable that he should make use of his acquisition in the perusal of the works of those writers who have contributed to the progress of man and the renown of their native tongue.

It too often happens that those who have laboured through the toilsome task of learning French in a scholastic fashion get tired of the drudgery involved in the study, and just leave off when the enjoyment of reading the records of life in other lands and in another tongue has become possible, and the true profit of their exertion is within their reach. The labour undergone has brought the student to the top of a hill whence a wide and diversified prospect opens to his view, but, rejoicing in the end of his cares, he closes his eyes on the outspread beauty and magnificence before him, and leaves the landscape unseen and unenjoyed. The language being learned its literature should be read, we should keep company with the choicest minds that have employed it, and accustom ourselves to the style of speech of the best masters of its words and phrases. In this way it will incorporate itself with our thoughts and become a possession and a delight. Literature is language in flower and fruit—thought that has blossomed and ripened.

Though we might mention, in a classified list, a number of the classical works in French literature in such an order as might guide through a progressive course of reading, proceeding from the simple to the more difficult, that would scarcely satisfy the different classes of students, who have not only differing wants but varying tastes. It seems better therefore that we should endeavour to exhibit with extreme brevity, yet with some sharply defined notes of appreciation, a concise account of French literature, such as shall bring into view its epochs, its authors and their works, in a form which, though epitomized to the utmost, may make plain the main course of intellectual progress and social life marked by its chief men and writings.

The Celts of ancient Gallia have left no specimens of their early poetry. Under the rule of Rome Latin became the language of culture in old Gaul, and many poetical writers in that land have won fair fame among writers of Roman verse. Though the Greeks, six centuries before the Christian era, colonized Massilia (Marseilles), and no doubt diffused some knowledge of their melodious language among the inhabitants of Southern France, we have no traces of its influence on the literary expression of thought. The invasion and settlement of the German tribes affected the common usages of the Latin tongue, and not only corrupted it with alien idioms, but influenced the grammar of extempore discourse. The Latin, modified by the Celtic and Teutonic elements, made current in the fields and the market-places, degenerated into a *Lingua Romana Rustica* wherever the barbarian invaders established their power amid the ruins of the Roman civilization. This rustic Latin speech (called Romanic) took two forms, separated by the river Loire: (1) that on the south, in which Latinisms prevailed, called *Langue d'oc*, and (2) that on the north, in which Celtic and Teutonic idioms had greater force, called *Langue d'œil—oc* and *œil* being the old forms respectively of the modern *oui*, yes.

Literature first flowered into poetry in the southern provinces. Its early singers were designated *troubadours* (Provençal, *trobar*, to find). By the crusade against the Albigenses (1209–29) and the loss of independence in Southern France the songs of the troubadours were silenced. Yet of this crusade we have a metrical chronicle; many of the sweet hymns of the Vaudois of that time survive; and a version of Boethius' "De Consolatione Philosophiæ," as well as a few narrative poems by various authors, remain. Among these early versifiers were kings, dukes, counts, and warrior-knights of historic name. Their metres and rhymes are complicated, and on them the earlier Italian poets modelled their lyrical strains. The Provençal tongue has sunk into a *patois*. It is still used in several dialect-forms in the south of France, in Western Spain, in Sardinia, and in the Balearic Isles. The poets of the northern division were known as *trouvères* (French *trouver*, to find). They have left many metrical romances—(1) *chansons de geste:* lays regarding historic and heroic exploits; (2) *lays of the Round Table*, introducing love and friendship into their narratives; and (3) *fabliaux*, metrical tales of fancy, frequently of an Oriental cast, and generally intended to stir the emotions—serious or ludicrous —and sometimes didactic. The original writers of this class were Normans. Wace's "Brut d'Angleterre" and "Roman de Rou" (*i.e.* Rollo), Benoit St. Mons' "Romance of Troy," and a celebrated metrical history of Alexander, written in verses of twelve syllables, from which the name "Alexandrine verses" is derived, are among these.

The decline of the literature of the French troubadours, the centralization of the government of France at Paris, and the founding of a university there, secured predominancy to the northern speech, and made it the literary language of France—the speech of the vulgar retaining much of its provinciality. In point of fact, the lays, apologues, romances, chronicles, fabliaux, tensons, and lyrics of the troubadours and trouvères form a literature and a study of themselves, requiring special historic knowledge and linguistic gifts to realize their allusions and to comprehend the grammar, lexicon, and structure of the old language. To products of the prodigious activity of these antique singers Dante, Petrarch, Boccaccio, and others of the earlier notables of Italian letters, as well as Chaucer, Spenser, and many English writers, owe much of the matter of their work, and more of the manner of their verse. Scholastic writers employed mediæval Latin in the exposition of their serious themes, and the popular speech, from its numerous variations in one province from another, was incapable of being used for other purposes than the sprightly play of fancy about the lighter and more trivial incidents of life and society. Masterpieces require a fixed and widespread language as a vehicle for the conveyance of the thoughts they contain. The consolidation of states, some general sameness of sympathies and interests, and the diffusion of culture to some extent, are required to inspire author and audience. Of course personal satire, political and religious impressions, and allegories of life, history, or science affect all communities and have attractions for even small bodies. But literature implies something of a national growth or of a race-product, receiving recognition as a valuable contribution to the intellectual wealth of those who comprehend its meaning, feel its influence, and delight in it as a mutually possessed joy. Passing over the *poésies* of Thiebaut, king of Navarre (1201–53), the "Roman de Renart" (Reynard the Fox), and even the more celebrated "Roman de la Rose" of Guillaume de Lorris and Jehan de Mehun, and noting by name only the allegorical poets Jean du Pin and Gaston de Foix, we come to such works as may really be regarded as the beginnings of French literature in its present form.

One cannot but remember how these singers of mediæval France awoke in the hearts of their contemporaries the sense of the melody of verse, and laid up treasures of legendary history and romantic fictions which formed the wealth of later ages. Their favourite heroes were Alexander, Arthur, and Charlemagne. The Norman *jongleurs* sang at the head of the army of William the Conqueror, before the battle of Hastings (1066), of Charlemagne, Roland, and Oliver. In the old romance of "Les Vœux du Paon" we are told, in French quite readable, though 800 years old, that

"Cils jongleors eurent bonne soldée,
Plus de cent marcs leur valut la journée;
Qui fut gentil de cœur sa robe dépouilla,
Et pour faire s'honneur à un d'els la donna."

("These jongleurs then obtained good pay,
More than a hundred marks they made per day;
He who was kind of heart stripped off his robe,
And to do honour to them gave it to one of them.")

Simon du Fresne, an Englishman, translated into French didactic verse that great work which closed the cycle of classic composition in Europe, Boethius' "Consolations of Philosophy." Bertrand de Born, a warlike knight and a good poet, distracted Guienne and the royal family of England, setting the sons of Henry II. against each other, and both against their father—for doing which Dante has placed him in Inferno. But when the gallant though misled young Henry fell ill and died (11th June, 1183) De Born, taken prisoner, on being reproached by Henry Beauclerc for having boasted of courage, replied, "I could do so once; but since your son died I have lost all my spirit and dexterity." Two of his poems are elegies on Henry, as "the noblest king e'er mother bare." Our Richard I. holds a place among the pleasant rhymesters of the crusading era, and both in the language of the troubadours and the trouvères a prison-song of his is found. The legend that it was by singing under the fortress wall of Lowenstein a tenson made by himself and the prince that Blondel discovered the captive Richard, supports his claim to mention along with Sordello, Peyrols, Vidal, Rudel, and Folquet, the counsellor of Simon de Montfort—writers of harmonious verse in lyric measures.

Another link between the literature of France and the history of England is the poetry of Charles, duke of Orleans, who was at once the last of the trouvères and the first of the followers of Italian models. Son of the first Duke of Orleans and the Italian Princess Valentina Visconti, he united both influences. He was taken prisoner at Agincourt, 1415, and dwelt in captivity in England for a quarter of a century. Here, to while away his loneliness, and rather to divert than embody his thoughts, he composed poems in French and English. Love's mythology and all the allegorical personages who have and hold dominion in that empire enjoy themselves in the hermitage of thought, wander and ruminate within the shade of the woods of melancholy, and endure hardness in the forests of sorrow. A sweet play of words, delicately expressive of soft sensibility, though without strength of passion or depth of thought, marks most of what he wrote; but the exquisite carving has been expended on fissile clay, not marble. Here is a glistening drop from this early fountain of French song, on spring-time and the change it brings—

"Le temps a laissé son manteau
De vent, de froidure, et de pluie,
Il s'est vestu de broderie
De soleil luisant, clair et beau;
Il n'a beste ni oiseau
Qu'en son jargon ne chante ou crie.

Le temps a laissé son manteau
De vent, de froidure, et de pluie,
Rivière, fontaine, et ruisseau,
Portent en livrée jolie;
Gouttes d'argent d'orfèvrerie;
Chacun s'habille de nouveau.
Le temps a laissé son manteau
De vent, de froidure, et de pluie."

("Old Time has doffed his former dress
Of rain and cold and bitter wind,
And clad himself in robe refined
Of sunshine's glittering loveliness;
Nor beast nor bird all here about
But, in glad tone, doth sing or shout.
Old Time has doffed his former dress
Of rain and cold and bitter wind,
River, and stream, and fount we find
Haste onward, free from their duresse;
Bedight in gold and silver too
Everything is clothed anew.
Old Time has doffed his former dress
Of rain and cold and bitter wind.")

Curiously enough, a far more influential writer than this unfortunate duke belonged to the lower order of French society. This was François Villon, a frequently imprisoned criminal (whose real name was Montcorbier, 1431–90). He lived a gay Jack-Sheppard life, and ran into rhymes the record of his lawlessness in his "Repues Franches" (Free Delights). His verve, gaiety of heart, wit, and airy nonchalance, his graceful pathos, melodious playfulness, and realistic humour, give his verses a widespread popularity among the unconventional and the *roturiers*. He is the quaint Heine of the sansculottes. His verses have often a tear accompanying their smile. With five of his companions he was condemned to death, and the night before the day appointed for his execution he sang thus of his expected exposure in chains—

"La pluye nous a débuez et lavez,
Et le soleil desséchez et noirciz;
Pies, corbeaulx, nous ait les yeux cavez,
Et arrachez la barbe et les sourcilz;
Jamais nul temps nous ne sommes rassiz.
Puis ça, puis là, comme la vent varie
A son plaisir, sans cesse, nous charie,
Plus becquetez d'oyseaulx que dez à couldre;
Hommes, icy n'usez de mocquerie,
Mais priez Dieu que tous nous veuille absouldre."

("The rain has washed and laundered us [all fine],
And the sun dried and blackened [yea perdie!]
Ravens and pies with beaks that rend and rive,
Have dug our eyes out, and plucked off [*sans* fee]
Our beards and eyebrows; never are we free,
Not once, to rest; but here and there still sped,
Driven at its wild will, by the wind's change led,
More pecked of birds than fruits on garden wall:
Men, for God's love! let no gibe here be said,
But pray to God that he forgive us all.")

Translated by Swinburne.

Villon's "Little Will" embodies the age-old jest of leaving all his woes ironically to those who are free from them, and all that he has not to those who have no need of them.

Guillaume Coquillart, a canon of the Cathedral of Rheims, wrote in rustic verse political and satirical poems, from which many characteristics of the fifteenth century have been gleaned by the curious, despite the obscurity at once of the language he uses and the allusions he makes.

Literature receives its refinement, grace, and attractiveness from poetry; but it fixes itself as a useful and pleasant mode of recording facts and thoughts in prose. To make men's ideas a joy requires an artist in words; but less skill and greater commonplace are permitted to statements, reports, letters, essays, and narratives meant for immediate use.

We would scarcely invite a zealous young reader to undertake, in the primary stages of his studies, a perusal of the earlier French writers, even though Geoffrey de Villehardouin tells the history of the fourth Crusade with the nerve of a soldier and the verve of a poet, the staid gravity of a knight and the conciseness of a man who found composition both difficult and delightful; Jehan de Joinville, seneschal of Champagne, gossips with *naïf* discursiveness of times a century later than the Crusades; reproduces the scenes of the days of St. Louis of France, whose companion he was, and those of the court of Thiebaut, the poet-king of Navarre, setting them in a framework of comments and moralizing; or Jehan Froissart, the Valenciennes-born canon and treasurer of the church of Chimay, offers to tell of the court of Philippa of Hainault, Queen of England and patroness of Chaucer; of his meeting with Boccaccio at Milan; his intercourse with Gaston de Foix at Mazères; and to unroll to our view the panorama of his journeyings and experiences in the chief countries and cities of Europe. These, when familiarity has made reading easy, and one's interest in antique life and literature increases, he will peruse, at least their most brilliant portions, in due time. But though we cannot advise the reading of French in chronological order, it seems almost necessary to record the production of the chief works of the best French writers, with some regard to historical environment and association, in order that the matter to be placed before the student may take some form and fixed plan.

François Rabelais was born at Chinon, in Touraine, 1483. There his father was a farmer and keeper of an hostelry. The boy entered the convent of Fontenay-le-Comte, became a Franciscan monk, and was ordained priest in 1511. On account of the envy which his great learning excited, and the hatred and persecution which his attacks on the licentiousness of the priests aroused, he left the Franciscans and joined the Benedictine order in the abbey of Maillezais. The Bishop of Maillezais made him his secretary, and he donned the garb of a secular priest. Subsequently he went to the University of Montpellier, where he wrote and acted in plays, lectured and laughed, pleaded the privileges of the university in many languages, and broke its conventionalities in many ways, for two years. Next, on the invitation of Etienne Dolet, scholar, poet, and publisher, he went to Lyons, where he edited some of the works of Hippocrates, Galen, the medical letters of Manardi, &c.; but finding these attaining scant patronage he bethought himself of writing the "Chronique Gargantuine." It had an immense and instantaneous success. He followed that, in 1533, by "Pantagruel," book i., and in 1534 a considerably altered reissue of "Gargantua" was made. The early "Chronique" was a burlesque farrago of nonsensicalities parodying the romances of chivalry; but it showed his power, and opened an avenue to influence. The idea grew in his mind, burlesque became allegory, allegory satire, and satire philosophy—of a sort—all written in the vernacular, and intended only for men, not women, of whom Rabelais appears to have known little or nothing. As the work of a man of fifty, it is fleshly, and yet there are gleams of better, and glints of higher, things in it which make one wonder at the corruptedness of his early training. It gives an account of the birth, upbringing, education, and warlike prodigies of the great giant Gargantua. He required 1200 ells of linen for a shirt; 406 of velvet for his shoe-uppers and 1100 cow-hides for their soles; 17,913 cows were needed to provide him with suck; his toothpick was an elephant's tusk; the lettuces he ate were as big as walnut trees, and on one occasion he swallowed six pilgrims from St. Sebastian in a salad—whose adventures in the valleys and recesses of his mouth are related with diverting humour. He rode to school in Paris on a mare as big as six elephants, which had feet with fingers. Once, for a freak, he hung the bells of Notre Dame on its neck, but restored them on Janotus de Braginardo promising the Parisians would feed his mare at their expense. This mare (the court mistresses) had a tail (their suites) "every whit as big as the steeple of St. Mark's;" with a whisk it knocked down all the trees near; and so thick was its fell, that after a battle he combed the cannon-balls out of its hair. The education of Gargantua is conducted by pedants; he lives the life of a coarse peasant—combing his hair with a German comb (his fingers), and looks on washing as waste time. He feeds gluttonously, learns little, and sleeps much. Under a new teacher, Ponocrates (patient power), he gets new habits and tastes; he prays, studies scripture, hears lectures and scholarly discourse, plays tennis, eats moderately, and learns to talk of real things: he

rides, sings, takes exercise, studies plants, sups, watches the stars, plays (instructive) cards, prays, and goes to bed. Friar John's Utopian convent, "Theleme" (The Will), where no monk is to enter, where only the good and the beautiful (men and women) are to live, at the good pleasure of their will, appears in the second issue.

Gargantua marries Bodebec, who dies in giving birth to Pantagruel, who is wonderfully brought up. There are few things wiser or better than Gargantua's letter to his son on education. In Paris Pantagruel (all-thirst) meets Panurge (all-wit), the penniless practical joker, whom he makes lord of Salmygoudin, in the land of the Dipsodes, with an annual revenue of £67,000,000, but in a fortnight his lordship forestals three years' income, and philosophizes on the blessedness of being in debt. Alcofribas Nasier (an anagram of François Rabelais), "abstractor of this quintessence," was castellan to Panurge. Of the journeys of Pantagruel, conqueror of Anarchus and colonizer of Dipsody, accompanied by Panurge, to the Islands of Shrovetide, Papifique, and Papimanie, with what occurred on the several voyages in their visits to Homena, to Gaster (the stomach), the first master of arts in the universe, to the Pope-hawks (and his sacred co-immigrants, from the land of Lack-bread to the Island of Bells, on to the visit they paid to Queen Quintessence, in the land of Eutelèchie (speculative science), and the consultation of the Oracle of the holy Bottle, it is impossible even to give a hint. Amid all his buffoonery and satire he never blasphemes the Holiest, nor touches with mock, jeer, or sarcasm the gospel and him made known therein.

Margaret of Navarre was one of the protectors of John Calvin; and to her brother, Francis I., the reformer dedicated the French translation of his "Institutes of the Christian Religion," published in 1536. The dedication is a masterpiece of argumentation, rising into eloquence. The work to which it was prefixed and his "Commentary on the Scriptures" were both issued by the severe and haughty Calvin in the language of the common people. For many years the Noyon-born leader of the church militant filled Europe with the new ideas which stirred the world and made his writings powerful throughout many lands, by indoctrinating the minds of men with the theory of freedom of thought and debate. La Boetie, the early friend of Michel de Montaigne, lavished all his pains and powers in his precociously thoughtful book, "The Treatise on Voluntary Servitude," to claim this liberty in politics as well as in religion, and to declaim against that saddest sight in the universe—the martyrs for freedom of soul and body perishing amid the curses of those crowds for whose sake they endured the dungeon, the scaffold, and the stake. Montaigne, La Boetie's friend, edited a translation of a treatise on "Natural Religion," by Raymond de Sebonde (died 1432), issued the minor works of the Sarlatian opponent of willing submission to oppression, allowed a copy of that work by the Perigord patriot to slip through the press as if by chance, and in 1580 published the first edition of his own essays. These he subsequently most sedulously revised, and to them he added a third book. This work has secured the admiring love of everybody. In it the author inaugurated popular philosophy. "He is," as Lord Jeffrey has said, "the first conspicuous writer who in a modern language philosophized on the common concerns of men, the ordinary subjects of private reflection and conversation." In him, using the antithesis of Montesquieu, *l'homme qui pense* prevails over *l'homme qui écrit*. Men who both cared and dared to think in his day were not too numerous, and even such men had no smoothly polished, definitely logical, widely-diffused and well-known language in which to express their thoughts. "In our tongue," Montaigne says, "I find plenty of *matter*, but little *manner*." Their shrewd, good-hearted wiseness and keenly sceptical, superstition-touched thoughtfulness have made these essays a treasury of suggestive observations. His readers become actual—nay, intimate—friends of the easy, kindly, smiling, humorous lord of Montaigne, and yet are so well acquainted with his foibles and fancies, likes and dislikes, home, wife, children, and servants, books and friends, that they receive, as if from a gift-giving good old uncle, the narrative of his thoughts just as they rise in the memory or the mind, which in that age—confessing thus his incompleteness in this incomplete world—took for its motto, "I do not understand, I pause, I examine." His essays are really the intellectual recreations of a reading man. They show us the interior of his mind, and hence he says, "This book is consubstantial with myself." Here are just a dozen sayings from his essayings—"Man is mad; he can't make a monkey, yet he makes gods by dozens;" "Knowledge ought not to be stuck *on* the mind, but incorporated *with* it;" "Our minds are never *at* home, but ever *beyond* home;" "It is not a soul, nor is it a body, we have to train, it is a *man;*" "The mind is ill at ease when its companion has the colic;" "We are all richer than we think, but we have all been taught to go abegging;" "Life in itself is neither good nor bad; it is the *place* of what is good or bad;" "It is more difficult to command than to obey;" "Obedience is never pure and calm in him who reasons and pleads;" "The bees fly here and there rifling the flowers, but of them they make honey which is all their own—it is no longer thyme nor majoram;" "We learn to live when life has passed;" "I will take care, if possible, that my death shall say nothing that my life has not said." But what is that he whispers into our memory, rebukingly—"Every abridgment of a *good* book is a stupid abridgment."

Jean Bodin, whom Montaigne knew and admired, in his "Republic" (1577), gave origin to politic science in France. He was widely learned and wisely thoughtful. Jacques Amyot—tutor to the children of Henry II., great almoner of France, and Bishop of Auxerre—translated Plutarch into such excellent, easy, and natural French that Montaigne says of it, "We poor ignoramuses would have been lost if this book had not lifted us out of the mire; thanks to it we may now dare to speak and write, and ladies can teach schoolmasters. It is our breviary."

Francis I., by his love of song, music, and the drama, gave indirect encouragement to the culture of taste and the refinement of the languages. The imperishable remains of classic literature were made known to the world by the close of the ancient civilization and the uprise of the Renaissance. Not only were learned men then dispersed among the nations, but books began, by the art of printing, to be diffused among scholars. The overweening kingly chivalry of Francis, perhaps due to, but at least nourished by, the study of the romanticists of Italy, encouraged in his court poetic imagination and voluptuous elegance. By the advice of Budæus—whom Erasmus styled "the wonder of France," for his Hellenic lore, and whose treatise "De l'Institution d'un Prince" yet holds a place in the educational library of his native land—Francis established the "Collège de France." By this and other efforts to invite to study and supply culture he won for himself the title of "the father of French literature." His sister, Margaret of Valois, queen of Navarre, not only wrote many delicate and musical verses, but was the compiler, editress, and in part author, of "L'Heptameron," or the History of Fortunate Lovers (1558), an imitation of Boccaccio's "Decamerone," which is almost the earliest narrative prose in French which can be read without a special glossary.

The reign of Henry II., who succeeded his father, Francis I., in 1547, produced quite a host of poets, and is notable for the new form of poetry introduced by them. Francis Herbert (1520–1590), author of "Le Temple de Chasteté" was the poet-laureate of Henry's court; Melin de St. Gelais, whose works were issued at Lyons, 1574, was almoner of the king, and is reputedly the introducer of the sonnet and the madrigal; Maurice Seve, of Lyons, composed dixaines—ten-lined rhymes—to Delia; Theodore Beza welcomes the sovereign to the throne in pleasingly pathetic strains, and besides writing many other poems, versified the Psalms of David; Jacques Peletier du Mans, poet and mathematician, translated Horace's "Art of Poetry" in 1545, and ten years afterwards adapted its teachings to the improvement of French verse. But the chiefs and leaders of the poetical revolution of that age were men whose efforts attracted the efforts of all France, and led to their being spoken of as *the Pleiad*. Among these was Pierre de Ronsard, descended from a Hungarian family, and born in Vendomais, 1525. He studied at the College of Navarre, served the Duke of Orleans, and then transferred his services to James V. of Scotland. Having travelled a good deal, and having been overtaken by deafness and by love, he

retired to the College of Coquerel, and there during seven years prepared himself for making an improvement on the language and literature of France. This design he communicated to Joacquim du Bellay, who had just issued some forms of verse untried in French before. One of the results of this conversation was the issue by Du Bellay of the "Defense et Illustration de la Poésie Française" (1549), in which he commended to his countrymen the introduction of the epigram, elegy, eclogue, odes, sonnets, and satires. Ronsard at first quarrelled with the author of this premature publication of his plan for a poetic reformation founded on a revival of classicism, but he afterwards co-operated with that writer, who won the designation of the French Ovid in his "Olive" and his "Régrets," while he endeavoured by his "Franciade" to acquire the laurels of the Virgil of France. Ronsard emulated the Mantuan singer, the Venusian bard, and Petrarch as a sonneteer and canzonist. He was a favourite with Elizabeth of England and Mary Queen of Scots, and it was his hymn, "De la Mort," which Chastelar had repeated to him while he died on the scaffold charged with attempting the honour of the latter sovereign. Jean Antoine de Baif aided the innovators and composed graceful imitations of Greek and Roman verse, which did much to fix the rules of French metre. At his suggestion the first French Academy was founded, 1570. Jean Dorat, the "golden," sang in a sweet melodious style. Remi Belleau put into rhyme Ecclesiastes, the Song of Solomon, and the Odes of Anacreon, besides issuing a rather smart macaronic burlesque poem, "De Bello Huguenot." Pontus de Thiard was not only Bishop of Chalons-sur-Saone, but a court singer of some grace and power. Etienne Jodelle, Lord of Lymodin, founder of the stage in France, delighting the court of Henry II. by his dramatic compositions, strove to imitate rather than translate the masterpieces of antiquity. He performed the part of Cleopatra in his tragedy of that name; his comedy "La Rencontre" was highly popular, and both Remi Belleau and Jean de la Peruse acted the chief parts in it at court and in the College of Boncour. Some authorities, rejecting Jodelle as a dramatist, introduce Amadis Jamyn, secretary to the king, as a member of the Pleiad. His translation of part of the Iliad is considered a worthy endeavour, if not quite a success. His "Œuvres Poétiques" were issued in 1575.

Of the poetry of Guillaume de Salluste du Bartas, who, under Henry V., was sent as ambassador successively to Denmark, to Scotland, and to England, and who won reputation both as a statesman and a poet, we need scarcely speak here. King James I. translated his "Urania," and Joshua Sylvester gave to English literature (see p. 771) a translation superior in many points to the original. Gui de Faur, Seigneur de Pibrac, the apologist for the massacre of St. Bartholomew's Day, imitated Theognis by writing moral *quatrains* for the guidance of human life. They have been translated into all the languages of Europe. Sylvester translated them under the title "Tetrastica," and dedicated his "Triumphs of Faith" to their author. Here is one of Pibrac's quatrains versified by Sylvester—

"Fouy jeune et viel de Circe le brumage;
N'escoute aussi des Sirènes les chants,
Car enchanté tu courrois par les champs,
Plus abrutez qu'une beste sauvage."

("In youth and age shun Circe's baneful bowle;
Lend not thine ears to Sirens' wanton notes,
Lest thou, enchanted in thy sense and soule,
Become more brute than hogs, and dogs, and goats.")

Robert Garnier, as a playwright, has been brought within reach of English readers by Mary, countess of Pembroke. Jean de la Tuille, in comedy, by his "Corrivaux" gained a high place; but the Italian Guinte (under the translation of his name, *l'arrivé*), as Pierre de Larrivey, by his "Comédies Facétieuses" (1579) rivalled Jodelle in theatrical acceptance. Philippe Desportes, by the study of Tibullus, was led to reject the pedantry and affectation of the Pleiadists, and wrote with tenderness and grace. His sonnets are regarded with favour.

After the death of Henry II. "the waters drawn from the fountains of Parnassus were," says Etienne Pasquier, "somewhat troubled." Louisa Labé was a skilful writer of elegiac verses, and the Mesdames Desroches of Poitiers (mother and daughter) sang like the lark and the nightingale among birds. Maturin Regnier, nephew of Desportes, strove to defend the Pleiad, and was a successful writer of satire. Sainte-Beuve calls him the Montaigne of poetry—full of genius and good sense, and quick at turning a popular idea into a proverb. The satire "Menippe," composed by Jean Passerat, Nicolas Rapin, and several others of the wits of that age against the League, obtained great *éclat*. The first almoner of Catherine de Medici, the Abbé Bertaut, sang with much lyric harmony. François Malherbe—born at Caen 1553, entered the service of the vigorous "Béarnais," who overcame the League and created a national party—is the accredited creator of modern French in choice of phrase and clearness of expression. He devoted himself to the culture of French style. Though his fame among his contemporaries was chiefly that of a grammarian, he was a poet of remarkable gifts for precise expression. He was the prophet, apostle, and precursor of the Grand Age. The Hôtel de Rambouillet and the Académie Française were really the results of his influence, and Boileau was right when he sang of him—

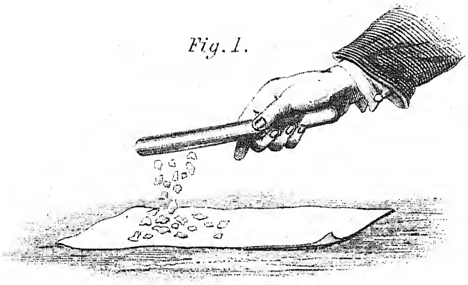
"Enfin Malherbe vint, et le premier en France
Fit sentir dans les vers une juste cadence,
D'un mot mis en sa place enseigna le pouvoir
Et reduisit la Muse aux règles du devoir;
Par ce sage écrivain la langue reparée,
N'offrit ne rien de rude à l'oreille épurée;
Les stances avec grace apprirent à tomber,
Et les vers sur les vers n'osa plus enjamber.
Tout reconnut ses lois, et le guide fidèle;
Aux auteurs de ce temps sert encore de modèle."

NATURAL PHILOSOPHY.—CHAPTER XXVII.

STATIC ELECTRICITY.

ELECTRIC ATTRACTION AND REPULSION—CONDUCTIVITY—GOOD AND BAD CONDUCTORS—THEORY OF STATIC ELECTRICITY—SOURCES OF ELECTRICITY—ELECTROSCOPES—LAWS OF ATTRACTION AND REPULSION—TORSION ELECTROMETERS—COULOMB'S LAW—DISTRIBUTION OF ELECTRICITY—DENSITY—TENSION—LAWS OF DISTRIBUTION—ELECTRIC POTENTIAL—CAPACITY—DISSIPATION OF CHARGE—ELECTRIC INDUCTION—QUANTITY OF CHARGE—INDUCTIVE CAPACITY—DIELECTRICS—DIELECTRIC POLARIZATION—ELECTROPHORUS—ELECTRICAL MACHINES—INDUCTION MACHINE—ELECTRIC SPARK—ELECTRIC CHIMES—CONDENSERS—LEYDEN JAR—RESIDUAL CHARGE—LEYDEN BATTERY—MEASUREMENT OF CHARGE—VOLTA'S LAW—CONTACT OF DISSIMILAR METALS—ELECTRIC DISCHARGE—DURATION OF THE SPARK—VELOCITY OF ELECTRICITY—LIGHTNING—LIGHTNING CONDUCTORS.

WHEN a piece of sealing wax, resin, or a glass rod is rubbed with a piece of silk or flannel, it acquires a property which it did not possess before—namely, the power of attracting to itself light substances, such as bits of paper, chaff, &c. (fig. 1, Plate XXIII.) The same attracting force may be observed when a small cork or pith ball is suspended by a fine thread (fig. 2), and a warm glass tube previously rubbed with a silk handkerchief is held near it; the pith ball will be strongly attracted, showing that it is highly electrified, but after momentary contact is again repelled, nor will it be again attracted until it has touched some body in conducting communication with the earth, and given up the electricity which it had acquired from the glass. From the fact that this property of attracting light bodies when rubbed was first observed by the Greeks in amber (Gr. *electron*), the force which causes these and other phenomena has been called *electricity*. Some substances, such as metals, do not appear capable of electrical excitement, for although a rod of metal held in the hand may be rubbed with silk or flannel, no electrical effect is apparently produced in it. Again, if a dry glass rod be rubbed at one end and brought near to a pith ball, it will be found that only the rubbed end is excited, the other end producing neither attraction nor repulsion on the pith ball; a rod of sealing wax or shellac produces the same results. Therefore in these substances the electricity does not pass



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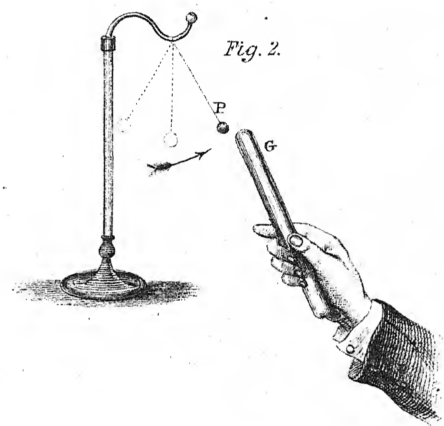

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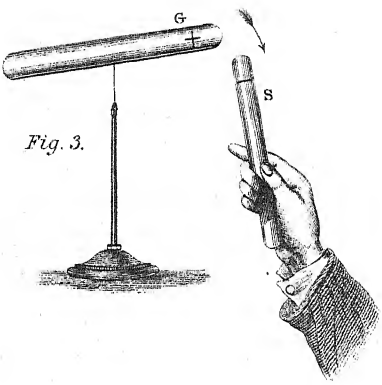

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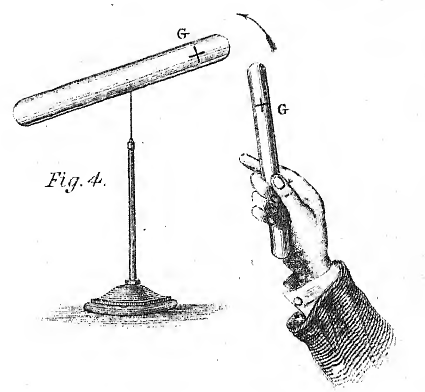

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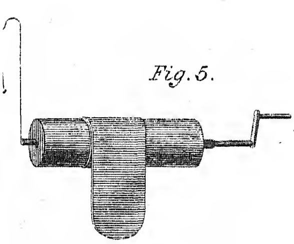

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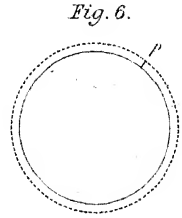

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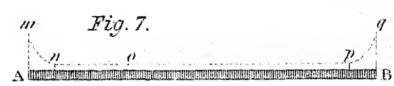

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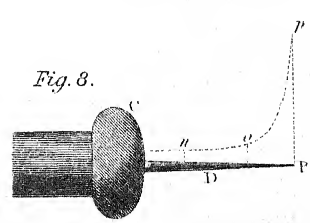

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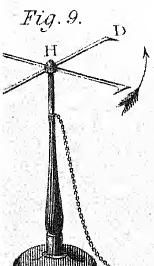

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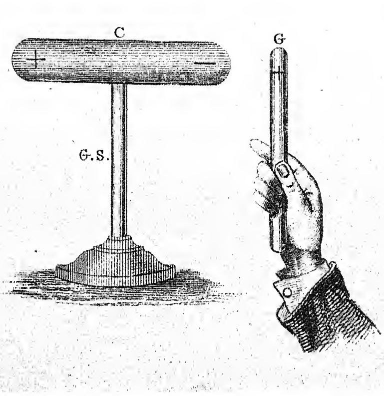

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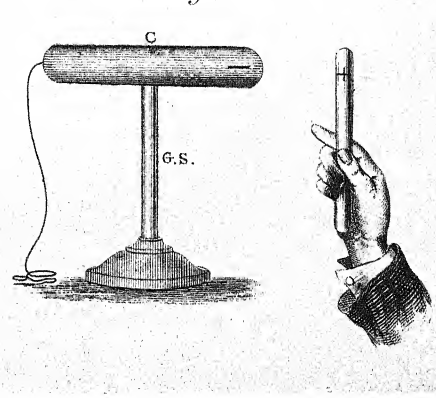


Fig. 11.

from one part to another, they do not conduct, while with metals the electricity instantly spreads over the entire surface, and they are said to be *good conductors*. All substances have therefore been divided into *conductors* of electricity and *non-conductors* of electricity, or insulators. These terms are, however, only relative, as there is no conductor so perfect but that it offers some resistance to the passage of electricity, neither is there any substance which insulates so completely as not to allow some to pass away. The following list of substances, arranged in the order of their decreasing conducting power, will show how insensibly conductors and non-conductors merge into each other.

GOOD AND BAD CONDUCTORS.

All the metals	Vapour of alcohol	Parchment
Well-burnt charcoal	Vapour of ether	Dry paper
Plumbago	Moist earth	Feathers
Concentrated acids	Powdered glass	Hair
Powdered charcoal	Flour of sulphur	Wool
Dilute acids	Dry metallic oxides	Dyed silk
Saline solutions	Oils	Raw silk
Metallic ores	Ice at 0° C.	Transparent gems
Animal fluids	Phosphorus	Diamond
Sea water	Lime	Mica
Spring water	Dry chalk	Glass
Rain water	Lycopodium	Jet
Snow	Caoutchouc	Wax
Vegetables	Camphor	Sulphur
Animals	Dry marble	Resins
Flame and smoke	Porcelain	Amber
Steam	Baked wood	Shellac
Soluble salts	Dry gases and air	Gutta-percha
Rarefied air	Leather	

Conductivity, however, depends on many physical conditions; glass, for instance, which at an ordinary temperature is a non-conductor, becomes a conductor at a red heat. In the same way shellac and resin are not such good insulators when they are heated. Water is a good conductor, but when in the state of ice at 0° C. is then a good insulator. Non-conducting substances are therefore used as supports for bodies in which electricity is to be retained. A conductor can only remain electrified so long as it is surrounded by insulators. From their great conductivity metals do not become electrified by friction; the electricity flows away as fast as it is generated. But if they are insulated and then rubbed they exhibit electrification. If the metal cap D of a gold-leaf electroscope (fig. 1, Plate XXIV.) be briskly flapped with a dry silk handkerchief, the gold leaves L^1, L^2 will diverge.

TWO KINDS OF ELECTRICITY.

Whenever a substance is electrically excited, there is always developed an equal amount of two distinct electrical states, the so-termed *positive* and *negative* electricities—one state appearing in the substance rubbed, and the opposite state in the rubber; that this is so, is demonstrated by the neutralization of the two equal and opposite electricities when imparted to a third body. If a glass rod, G (fig. 3, Plate XXIII.), after being electrified by friction with dry silk, be suspended on a point so that it can turn freely, and a stick of sealing wax, S, also electrified by friction, be brought near it, the glass will be attracted. If, however, another electrified glass rod, as in fig. 4, be substituted for the sealing wax, the movable rod will be repelled and will move away, thus showing that the electricity excited in glass has different effects from that excited in sealing wax.

In the following list the substances are so arranged in order that if any two be rubbed together, the one which stands earlier in the series becomes positively electrified, and the one that stands later negatively electrified.

Fur	Silk	Resin
Wool	Wood	Sulphur
Ivory	Metals	Gutta-percha
Glass	India-rubber	Gun-cotton
Cotton	Sealing wax	

In the various theories that have been advanced to account for these phenomena, the supposition of an *electric fluid* has generally been maintained, and the terms positive or + and negative or − employed, but the use of these terms is purely conventional, as in the present state of our knowledge it is undetermined which of these two conditions really indicates the excess, or which means the deficiency. One thing is however certain, that electricity is *not a fluid* in the general acceptance of the term, for although it follows in some particulars the characteristics of a fluid in flowing apparently from one point to another, it differs from the laws of every known fluid, as it is without weight, and it repels itself. It is also difficult to conceive any two fluids whose properties should be in every respect precisely the opposite of one another. To term electricity a fluid is therefore incorrect, however convenient it may be to use that term in explanation of the various phenomena. The *molecular theory* of electricity enunciated by Faraday is more likely to be the true theory. It supposes that electrical states are the result of peculiar conditions of the molecules of electrified bodies, or of the ether which is supposed to surround the molecules. The present state of the science does not permit any theory to be definitely adopted, but inasmuch as magnetism is assumed to be due to a condition of polarity of the particles forming the body, it seems probable that electricity is likewise more or less connected with a certain molecular state of the substances in which it manifests itself. The term electricity is therefore employed without reference to any present theory. A body when electrified is said to be charged, whether the electrification (of either kind) is produced by friction or other means. When the charge of electricity is removed from an electrified body, it is said to be discharged, as is the case if touched by the hand, or by any conductor in contact with the ground, the charge at once finding a means of escaping to the earth. A substance that is not a good conductor may be at once discharged by passing it rapidly through the flame of a candle or spirit lamp, as the flame instantly carries off the electricity and dissipates it into the air.

Electricity either resides on the surface of bodies as a charge, or flows through their substance as a current. The laws of the charges upon the surface of bodies are termed *electrostatics;* those which treat of the flow through the substance of the body, *current* or *dynamical electricity*. The production of electricity by friction is manifested by other effects than those of attraction and repulsion; sparks and flashes of light are obtained from bodies in a highly electrified condition, accompanied by a sharp snapping noise. Pale flashes of light are also manifested by the electrical discharge through partially exhausted tubes.

SOURCES OF ELECTRICITY.

Electricity is generated not only by friction, but also by percussion, compression, heat, chemical action, physiological action, contact of dissimilar substances, cleavage, &c. If a plate of mica be rapidly split in the dark, a phosphorescent light is manifested, and the plates thus separated are electrified, the one positively (+) and the other negatively (−). On breaking a stick of sealing wax the two ends of the fracture also exhibit + and − electrification. Lump sugar, when broken or rubbed together in the dark, presents a luminous appearance from electrification. Friction between two different substances always produces electrical separation. The degree of electrification produced by rubbing two substances together is independent of the pressure and of the size of the surfaces in contact, but depends on the materials and on the velocity with which they move over one another. As, however, the quantity of electrification is not proportional to the amount of the actual mechanical friction, it appears uncertain whether friction is the real cause of the electrification; it is more probably due to the contact of dissimilar substances, and that on contact any two particles of the bodies have attained the opposite electrical states of + and −, which is only manifested by their being drawn apart. Electrical machines are therefore simply appliances for bringing dissimilar substances into intimate contact, and then separating the particles which have touched each other and become electrically excited.

Instruments for indicating the presence and kind of electricity developed are termed *electroscopes*, and those by which its quantity under various conditions is measured are called *electrometers*. A pith ball suspended by a silk thread

as in fig. 2, Plate XXIII., may be charged by touching it with the end of an excited glass rod. If the body to be examined, on being brought near it, attracts the ball its electricity is –; if it repels it, it is +, as like electricities repel, and unlike electricities attract, each other in a similar manner to the north and south poles of magnets. A very delicate electroscope is formed by a strip of Dutch metal attached to a slip of paper and suspended from a stick of sealing wax. Gilbert's electroscope consists of a fine metallic needle terminated at each end by a light gilded pith ball, and balanced horizontally at its centre on a fine point. The + and – action of any electrified body presented to one of the balls is indicated by the movement of the needle. Bennet's gold-leaf electroscope consists of a couple of strips of gold leaf, L^1 L^2 (fig. 1, Plate XXIV.), suspended to a brass rod passing through an insulating tube placed within a glass jar—the tube and rod being supported by a cork varnished with shellac or paraffin wax, to prevent the escape of the charge over the surface. At the top of the brass rod is a metal plate, D. This instrument, when kept free from dust and dry, indicates very minute quantities of electricity. To use this electroscope the leaves are first charged + by touching the plate with a glass rod that has been rubbed on silk, when the leaves diverge, as in fig. 2. Any body therefore charged + on approaching the electroscope will cause them to open still further (fig. 3), while on the approach of one charged – they will tend to close together (fig. 4). Henley's quadrant electroscope (fig. 5), is frequently employed to test large quantities of electricity. It consists of a pith ball, O, at the end of a light arm fixed to a pivot upon an upright rod. When the whole is electrified the pith ball flies out at an angle indicated on a graduated scale. This electroscope is generally employed in connection with the electrical machine and Leyden jar.

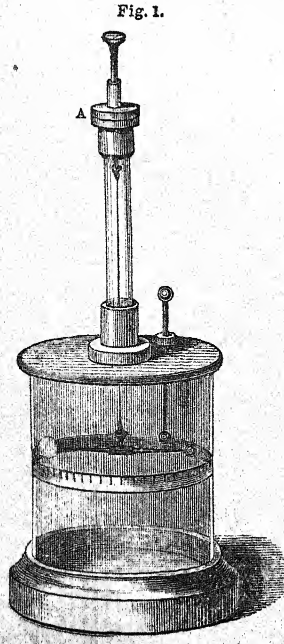
LAWS OF ATTRACTION AND REPULSION.

The laws which regulate the attractions and repulsions of electrified bodies are—

1. *The repulsion or attraction between electrified bodies is with a force inversely proportional to the squares of the distances between their centres.*

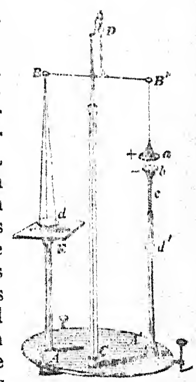
2. *The distance remaining the same, the force of repulsion or attraction between two electrified bodies is directly as the product of the quantities of electricity with which they are charged.*

Fig. 1.



These laws were determined by Coulomb with the aid of his torsion electrometer, shown in fig. 1. It consists of a glass cylinder, which is covered with a plate of glass 13 inches in diameter. This plate is perforated with two holes, one to receive a glass tube, 2 feet high, carrying on its upper end a torsion micrometer, A, to which is attached a slender silver or glass wire, the lower end of which carries a horizontal needle of straw or silk thread, covered with sealing wax. One end of the needle is terminated by a ball of elder pith, and the other end carries a vertical vane of paper covered with turpentine. A circular band, divided into 360 degrees, encircles the cylinder on a level with the needle, and through the other hole is introduced a small rod, B, the lower end of which carries another ball of elder pith. The instrument is adjusted by turning the torsion head, A, round until the two pith balls just touch one another. In this instrument the force of electrical repulsion is balanced against the reactive force of the glass or silver thread, which is twisted more or less from its normal position. In using the torsion electrometer the charge to be measured is imparted to the small pith ball connected with B. As soon as this ball and the one at the end of the needle touch one another the charge is divided between them, and the two balls repel one another, because they are then both similarly electrified. The ball at the end of the needle, therefore, is driven round and twists the wire up to a certain extent. The force of repulsion becomes less and less as the balls are further apart, but the force of the twist gets greater and greater the more the wire is twisted. Hence these two forces will balance one another when the balls are separated by a certain distance, and a large charge of electricity will repel the ball with a greater force than a lesser charge would. The angular distance through which the ball is repelled is read off in degrees on the scale. When a wire is twisted, the force with which it tends to untwist is exactly proportional to the amount of the twist, and the force required to twist the wire fifteen degrees is just fifteen times as great as the force required to twist it one degree; that is, the force of torsion is proportional to the angle of torsion. The angular distance between the two balls, when they are not very widely apart, is very nearly proportional to the straight line between them, and represents the force exerted between electrified balls at that distance apart. By means of the torsion balance Coulomb proved that the force exerted between two small electrified bodies varies inversely as the square of the distance between them when the distance is varied. Thus, if two electrified bodies, 1 inch apart, repel one another with a certain force, at a distance of 2 inches apart the force will be only one quarter as great, and at 10 inches it will only be one-hundredth part as great as at 1 inch. The truth of Coulomb's law has been confirmed by Snow Harris. The apparatus he employed consisted of a simple balance suspended from a brass hook, D (fig. 2), supported on a glass rod, O, through the centre of which passes a stout brass wire. A conducting substance, a, of any required form, is suspended by a double silver thread from one arm, B′, of the beam. This body is accurately counterpoised by weights, d, in the scale-pan suspended from the other arm, B; a similar conductor, b, is fixed immediately under the former, and is supported on a graduated sliding tube, c, insulated on the glass pillar d'. The pan, d, when loaded with given weights, rests on the small table, E, the altitude of which can be adjusted by means of a sliding tube. The whole is fixed on the base, A A′, furnished with three levelling screws. When the conductor b is charged – and the suspended conductor a + by means of the suspension thread and the wire passing through the column, c, then the attractive force arising from a given accumulation is caused to act immediately between these conductors, a, b, and may be measured under given conditions by weights placed in the pan, d.

Fig. 2.



DISTRIBUTION OF ELECTRICITY.

When a body receives a charge of electricity the charge does not, as in the case of heat, diffuse itself throughout the whole of its substance, but is confined entirely to its surface. From this it follows that a conductor may be formed of wood covered with tinfoil; it may be solid metal or hollow, but if the shape be the same the charge of electricity will be the same, and distribute itself precisely in the same manner over the surface. Biot illustrates this by taking an insulated cylinder (fig. 5, Plate XXIII.) movable round a horizontal axis, which may be turned by a glass handle. Around the cylinder there is wound a metallic ribbon. The apparatus is made to communicate with a pith-ball electroscope; when the ribbon is electrified the balls of the electroscope diverge; upon unrolling it the balls gradually collapse, indicating a

Fig. 1.

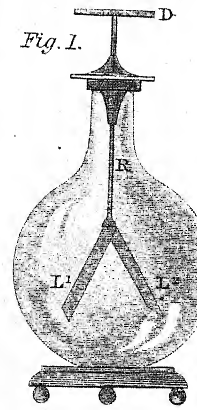


Fig. 2.

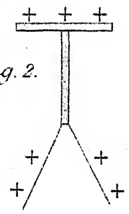


Fig. 3.

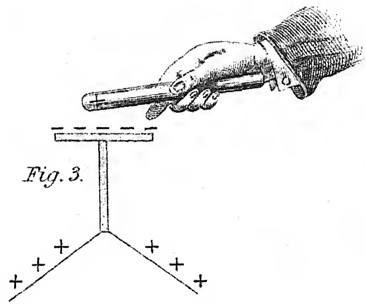


Fig. 4.

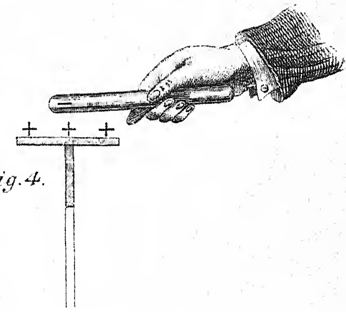


Fig. 5.

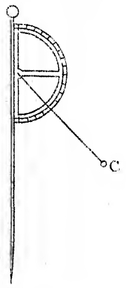


Fig. 6.

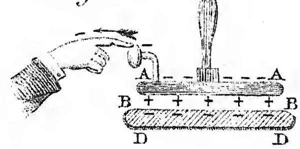


Fig. 7.

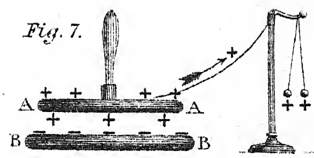


Fig. 8.

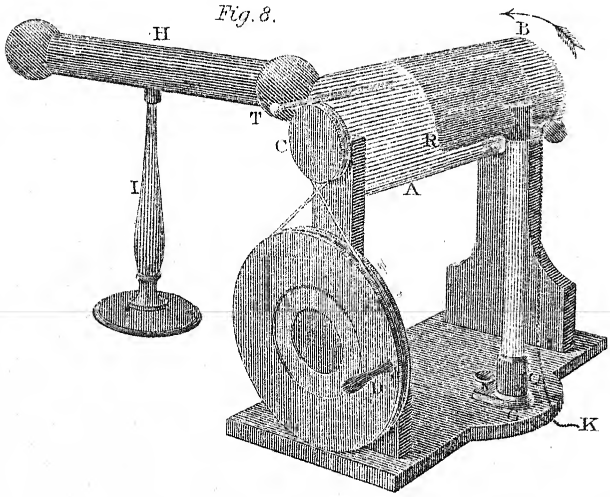


Fig. 9.

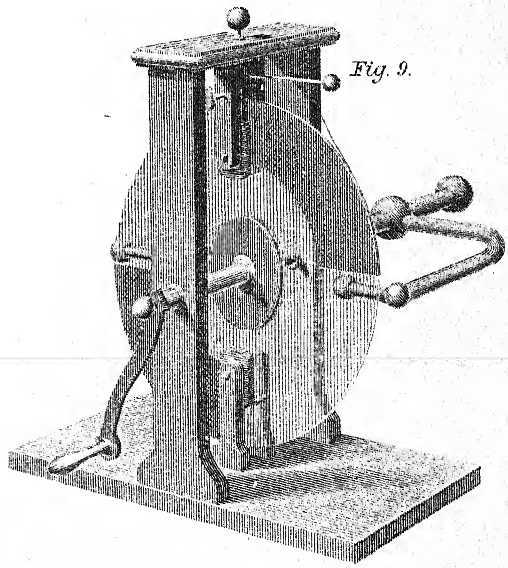


Fig. 8c.

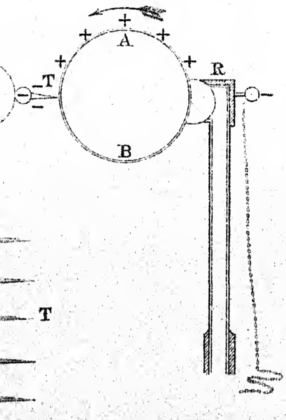


Fig. 8a.

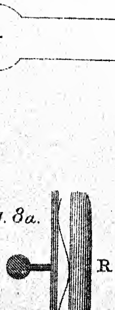


Fig. 8b.

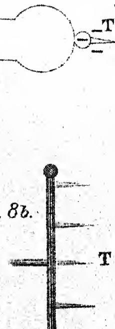
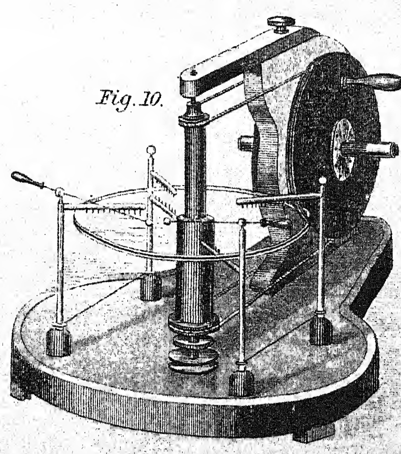
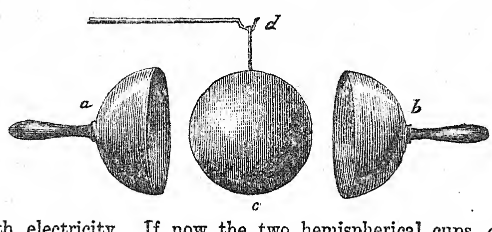


Fig. 10.



diminution of electrical charge, and if the ribbon be sufficiently long compared with the electrical charge given to the apparatus, they will entirely collapse, but will again diverge on re-rolling the ribbon on the cylinder. The quantity of electricity remaining the same, the electrical force on each unit of surface is therefore less as the surface is greater. The property of electricity of accumulating on the outside of bodies arises from the repulsion which the particles exert on each other. Electricity tends constantly to pass to the surface of bodies, from whence it continually tends to escape, but is prevented by the resistance of the feebly conducting atmosphere. This has been shown by means of a metallic globe, *c* (fig. 3), attached to a silk thread, *d*, which can be charged

Fig. 3.

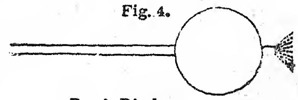


with electricity. If now the two hemispherical cups, *a*, *b*, with insulating handles, be applied to the globe and again removed, it will be found on testing with the electroscope that they have removed the entire charge from the ball *c*. It must, therefore, have passed to the outside of the cups when they were in contact with it. There are, however, two exceptions to the statement that electricity resides on the surface of bodies. When two opposite electricities are discharged through a wire, a phenomenon which when continuous forms an electrical current, the discharge takes place throughout the whole mass of the conductor. Also, when a body is placed inside a hollow-charged conductor, and insulated from it, it receives by induction a charge of electricity. The law is therefore limited to electricity at rest, that is, to statical charges.

ELECTRIC DENSITY.

When a metallic sphere is charged the distribution of the electricity will be uniform in every part, as shown in fig. 6, Plate XXIII. In the case of an elongated body it is found that the distribution of electricity is different at different points of the surface, being strongest at the most acute points. The term *electric density* or electric thickness is used to express the quantity of electricity found at any moment on a given surface. Therefore if S represents the surface and Q the quantity of electricity on that surface, if the electricity is uniformly distributed its electrical density is represented by $\frac{Q}{S}$. On an insulated conductor, where the electricity is in equilibrium, a particle of electricity will have no tendency to move along the surface, for otherwise there would be no equilibrium. But the electricity exerts a pressure on the external non-conducting medium, which is always directed outwards, and is called the electrical *tension*. The amount of this tension or pressure is proportional to the square of the electrical density. When two insulated spheres of equal size in contact with each other are charged, the density of the electricity is greatest at the parts furthest from the point of contact, and least at the point between them. If the spheres are of unequal size the density is greatest upon the smallest sphere, which has the surface more sharply curved. On a cone the density is greatest at the apex, and if the cone terminates in a sharp point the density at the point is much greater than anywhere else. At a point, *p* (fig. 8, Plate XXIII.), the density of the collected electricity may be so great as to electrify the surrounding particles of air, which being then repelled, a continual loss of charge takes place. The greater the density the greater the tendency of the electricity to overcome the resistance of the air and escape. When the hand is brought near a point on an electrified conductor a slight wind is perceived, and if the discharge of electricity takes place in the dark a luminous brush of lambent light is seen (fig. 4). For this reason sharp points and edges are always avoided in electrical apparatus, except where it is intended to set up a discharge. The density on a flat disc, A B (fig. 7, Plate XXIII.), is greatest at the edges, but over the flat surface, *n o p*, the distribution is nearly uniform. Riess found the density at the middle of the edge of a cube to be nearly two-and-a-half times as great as the density in the middle of a face, while the density at the corner of the cube was more than four times as great. When

Fig. 4.



Brush Discharge.

any portion of the charge of an insulated conductor is removed, the remainder of the charge immediately redistributes itself over the surface in the same manner as the original charge, provided the conductor is insulated. When a conductor charged with any quantity of electricity is brought into contact for a moment with another uncharged conductor of the same size and shape, the charge divides itself equally between the two conductors. A charge of electricity may be thus divided into three or more equal parts by being distributed simultaneously over three or more equal and similar conductors brought into contact with it. When two equal metal spheres suspended by silken threads, and charged with unequal quantities of electricity, are momentarily in contact, and then separated, the charge has redistributed itself equally, half the sum of the two charges being the charge of each sphere. This is the case when the charges are of opposite signs, for if one be charged with 6 units of + and the other with 4 units of − electricity, when these are brought into contact and then separated, each will have a + charge of 1 unit; for the sum of + 6 and − 4 is + 2, which divided between the two equal conductors is + 1 for each. When the conductors are of unequal size or of dissimilar form the quantity taken by each will be unequal, and in proportion to the electric capacities of the conductors, the larger conductor having a greater proportion of electricity imparted to it in order to electrify its surface to the same degree.

ELECTRIC POTENTIAL.

The quantity of electricity necessary to electrify an insulated body up to a certain degree is termed the *potential*, and depends upon its capacity. A large quantity of electricity imparted to a conductor of small capacity will electrify it up to a very high potential. When an electrified body is placed in conducting communication with the earth, electricity will flow from the body to the earth, if the body is at a higher potential than the earth, and from the earth to the body if the body is at a lower potential, and the flow will be proportional to the difference of potential. When the potential of a body is higher than that of the earth, it is said to have a + potential, and if lower than that of the earth a − potential. A body charged with free − electricity, is one of lower potential than the earth; one charged with free + electricity is at a higher potential. In the same manner as the level of the sea is taken as zero for the determination of the altitudes of mountains by the barometer, so the potential of the earth, the surface of which is always electrified to a certain degree, is taken as the zero potential, as a point of reference from which to measure differences of electric potential. The capacity of any conductor is measured by the quantity of electricity which it can acquire when placed in contact with a body which charges it to unit electrical potential. As with heat, which only passes from bodies of higher temperature to those of lower temperature, so also electricity passes from bodies of higher to bodies of lower electrical potential. Potential is therefore, electrically, what temperature is as regards heat. A short small wire heated to incandescence has a very high heat potential or temperature, greater than a vessel of hot water, but the latter will have a far larger quantity of heat units. A flash of lightning is electricity at a very high potential, but the quantity is comparatively small. When the charge or quantity of electricity imparted to a given body is increased, the potential increases at the same ratio. If Q be the quantity of electricity, C the capacity, and P the potential, then $Q = C P$; that is to say, the charge or quantity of electricity that any body possesses is the product of the potential into the capacity. For a sphere whose radius is R.

the potential $P=\frac{Q}{R}=C-R$, or the capacity of a sphere is equal to its radius. Although in many respects there is a close analogy between static electricity and heat, as regards capacity there are important differences; for while the capacity of a body for heat is influenced by temperature, the capacity of a body for electricity does not depend on the potential. Also heating capacity depends solely on the mass of a body, and in bodies of the same material and shape is proportional to the cube of homologous dimensions; the capacity for electricity is directly proportional to such dimensions, and not to the weight or volume. Heating capacity, again, is proportional to a specific coefficient, which varies with the material, and is independent of form; while electrical capacity varies with the shape of the body, and not with the material, provided the electricity can move freely upon it. Heating capacity is not influenced by the proximity of other bodies, while the electrical capacity depends on the position and shape of all the surrounding conductors. With heat, temperature means the quantity of heat; with electricity, the quantity or charge of electricity means the potential of electricity.

All electrified bodies gradually lose their electricity, although they may be placed upon insulating stands. The charge is gradually dissipated by the electricity either passing through the supports or escaping over their surface. This loss varies with the electric density, and also increases with the dampness of the atmosphere. The greater part of the loss of electricity appears to be due to the conducting layer of moisture which forms in the insulating supports, the loss by moist air being proportionally small. As glass is very liable to the condensation of moisture in its surface, it should always be coated with a thin layer of shellac varnish when used as an insulator.

ELECTRIC INDUCTION.

An electrified insulated conductor acts upon bodies in a neutral state placed near it in a manner very similar to the action of a magnet on soft iron; that is, it decomposes the neutral fluid, and attracts the opposite and repels the like kind of electricity. This action is termed *induction.*

If a glass rod, G (fig. 10, Plate XXIII.), is charged with + electricity and held near the insulated metal conductor, C, the natural electricity of the conductor is decomposed, and free electricity will be developed at each end, although the conductor itself has not been charged, and the ends of the conductor will attract small bits of paper; and if pith balls be hung to the ends they will be found to be repelled, while the middle surface of the cylinder exhibits no trace of electrification. The charge at the end of the conductor nearest the excited rod will be found to be −, and at the opposite end an equal charge of + electricity. This inductive action, which was discovered by Canton in 1753, is capable of taking place across a considerable distance, even though a sheet of glass be interposed between the bodies. On removing the glass rod both the induced charges disappear, but the glass rod is as much electrified as before, having parted with none of its own charge. If the conductor C (fig. 11, Plate XXIII.) be placed in connection with the earth, at the end furthest from the excited rod, that end only which is nearest the electrified body will be found to be electrified with the opposite kind of electricity to that of the glass rod. The quantity of the two charges separated by induction on a conductor in the presence of a charge of electricity depends upon the potential of the charge, and upon the distance of the charged body from the conductor. A highly electrified glass rod will produce a greater inductive effect than a less highly electrified one, and the nearer it is brought the greater the inductive effect. As the electrified body approaches, the charges of opposite sign on the two opposing surfaces attract one another more and more strongly, and accumulate more and more densely until, as the electrified body approaches very close, the tension becomes so great that a spark flies across, and the two charges combining neutralize one another, leaving the induced charge of (in this case) + electricity at the other end of the conductor as a permanent charge after the electrified body has been removed. From this it appears that a body can be charged with electricity by induction as well as by conduction, but with this difference—that in the former case the charging body loses none of its electricity; in the latter case it gives up a portion of its charge. Also, when a body is charged by induction the electricity imparted is of the opposite character; when it is charged by conduction it is of the same kind. To charge a body by conduction it requires to be insulated, while in the case of induction the body must be in communication with the earth, or at least momentarily so. Any electrified body acts by induction upon every other body placed near it, separating the neutral electricity in the same way. Bad conductors are not so readily acted upon by induction, owing to the resistance they present to the circulation of free electricity, but when once they are charged the electric condition is more permanent. The action of the magnet is similar, as it instantaneously magnetizes a piece of soft iron, but the imparted magnetism depends for continuance upon the action of the magnet; while again magnetism is imparted to steel with much greater difficulty, but once imparted the magnetization is permanent. Faraday's researches on induction prove that inductive action is influenced by the air which separates the electrified from the un-electrified body, and that the action of induction is not an action at a distance, or at any greater distance than that between any two molecules; for instance, if the intervening space were occupied by paraffin oil the effect produced by the presence of the electrified body would be much greater. The power of a body thus to allow the inductive influence of an electrified body to act across it is called its *inductive capacity,* and on account of this property these substances have been termed *dielectrics.* All dielectrics of necessity are insulators, but equally good insulators are not always equally good dielectrics. Glass is a better dielectric than ebonite, paraffin, or air, but air and glass are better insulators than ebonite or paraffin. Those substances which are good dielectrics are said to possess a high inductive capacity. Faraday regards non-conductors as consisting of a number of molecules which are absolute conductors, and are disseminated in a non-conducting medium. The action of an electrified body is to impart to the molecules, which are themselves polarized at the outset, a definite polar arrangement; those ends of the molecules which face the inducing body have electricity of the opposite kind, and those which are turned away from it have electricity of the same kind. In the interior of the medium, where the + of one and the − of the next face each other, the two forces neutralize each other; but where the non-conductor is bounded by a conductor, the free electricities are no longer neutralized, but form the charge which is manifested. According to this theory the action is analogous to that of the pole of a magnet on a piece of soft iron, and Faraday termed it dielectric polarization.

The following table gives the *specific inductive capacity* of some of the best insulators:—

Air,	1·00	Gutta-percha,	2·46
Glass,	1·90	Sulphur,	2·58
Paraffin,	1·98	Shellac,	2·74
India-rubber,	2·22		

These values are termed dielectric constants.

A simple and inexpensive apparatus for collecting large quantities of electricity by induction from a single charge is the *electrophorus,* invented by Volta in 1775. It consists (figs. 6 and 7, Plate XXIV.) of a round metal dish or sole, D D, about 12 inches in diameter, and with a rim about $\frac{3}{8}$ inch deep, in which is cast a cake, B B, of shellac or sealing wax, or a mixture of resin eight parts, gumlac one part, venice turpentine one part, melted together at a gentle heat, and a round cover, A A, of slightly smaller diameter, made of metal or of wood, covered with tinfoil, and furnished with a glass handle. When the electrophorus is to be used the resinous cake is flapped or rubbed with a warm piece of woollen cloth or with a cat's skin. The cover is then placed upon the cake and touched momentarily by the finger; on being removed by the glass handle it will be found to be powerfully electrified with a + charge, and capable of yielding a spark if the knuckle is presented to it. The process

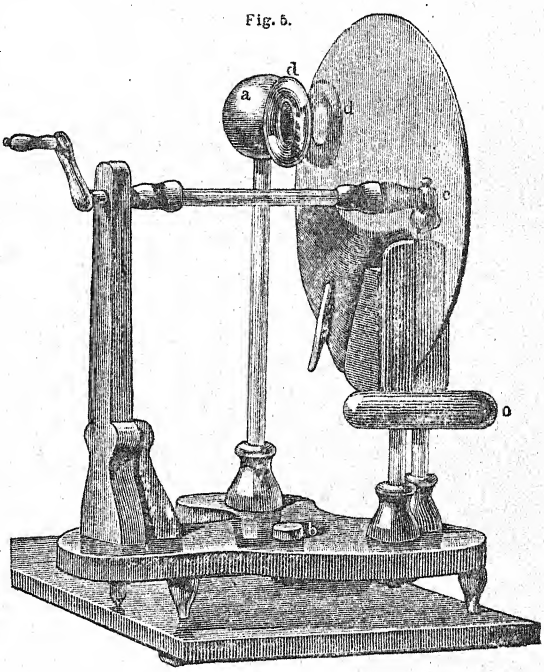
may be repeated an unlimited number of times without any fresh excitation of the resin being required, and if the electrophorus is kept in a dry place after being once excited a spark may be obtained from it during many weeks, since the resin acts solely by its inductive influence on the combined electricities actually present in the cover. The theory of the electrophorus is simple; on excitation the resinous plate is electrified; when the metal cover is placed in contact with it, on account of the inequalities of the surface of the resin, the contact is very imperfect; it is therefore in a condition analogous to that of a conductor under the influence of an electrified substance, its lower surface becoming + and its upper surface − (fig. 6, Plate XXIV.) The − electrification of the resin therefore acts inductively on the cover, attracting a + charge on the under side and repelling a − charge to its upper surface. When the cover is touched for an instant by the finger the − charge of the upper surface is neutralized by electricity flowing in from the earth through the finger and body of the operator, but the attracted + charge remains, being retained by its attraction towards the − charge of the resin. On lifting the cover by its handle (fig. 7 of Plate) the + charge on the lower surface, being no longer bound by attraction, distributes itself on both sides of the cover, as is shown by the divergence of the pith balls. It is clear, therefore, that the electricity of the cover is not derived by way of charge from the resin, but is the result of the process of induction, and that no part of the original charge has been given up in the process. The metal sole on which the resin rests forms an important factor in the action of the electrophorus, as it increases the quantity of electricity. For the − electricity of the upper surface of the resin, acting inductively on the neutral electricity of the mass, decomposes it, retaining on the under surface the + electricity, while the − electricity of the dish passes off into the ground. The + electricity thus developed on the under surface reacts on the − electricity of the upper surface, attracting it, and causing it to penetrate into the badly conducting mass of the resin, on the surface of which fresh quantities of electricity can be excited. It is for this reason that the electrophorus, once charged, retains its electrification for a considerable time. This instrument is a good example of the conversion of work into electro-potential energy, for the charge cannot be called into existence without the expenditure of some other form of energy. When the cover is raised from the electrified resin, work is expended to overcome the attraction of the opposite electricities developed by induction on the cover, and the equivalent of the work thus performed is the electricity detached, for it will be found that it is harder to raise the cover when it is charged with + electricity than if it were uncharged, for when charged there is the force of the electrical attraction to be overcome in addition to the force of gravity.

ELECTRICAL MACHINES.

The first electrical machine used by Boyle and Otto Guericke, with which they discovered electric light, consisted of a globe of sulphur turned on an axis by one hand, while the other pressing against it served as a rubber to excite the mass. The glass cylinder and the plate-glass electrical machines are the two forms now in general use, and the only important modifications that have been introduced are the substitution, in some cases, of ebonite for glass, and the construction of machines depending upon the principles of induction and convection. The cylinder machine (figs. 8–8*c*, Plate XXIV.) consists of a hollow glass cylinder, A B, mounted on glass supports on a horizontal axis, C, which may be turned by a handle, D. A cushion of leather, R, stuffed with horse-hair, the surface of which is spread with a powdered amalgam of tin or zinc and mercury, is fixed to a pillar of glass fitted with a metal conductor and furnished with a screw adjustment at the foot to regulate the pressure of the rubber on the cylinder. Attached to the rubber is a flap of oiled silk, which, passing over the cylinder, covers its upper half and prevents the dissipation of the electricity from its surface by contact with the air before it reaches the prime conductor, H T, which is made of metal, usually in the form of an elongated cylinder with hemispherical ends, and mounted on a glass stand, I. The prime conductor is furnished on the side nearest the cylinder with a series of fine metallic points, T, in the form of a rake. When the handle is turned the friction between the glass and the amalgam-coated surface of the rubber produces a plentiful electric action, electricity appearing as a + charge on the glass, leaving the rubber with a − charge, as shown in fig. 8*c*. When the machine is required to accumulate + electricity, a chain must be carried from the rubber to the ground, so as to allow the − charge to be neutralized. If − electricity is required to be accumulated, then the prime conductor must be put into communication with the earth, and the rubber insulated.

The plate electrical machine (fig. 9 of Plate) is constructed with a circular plate of glass or ebonite, revolving vertically by means of a handle, between two uprights; two pairs of rubbers, formed of slips of elastic wood covered with leather pads and provided with oiled-silk flaps, are placed at two equidistant portions of the plate, their pressure being regulated by means of screws. The prime conductor is generally curved round to meet the plate at the two ends of its horizontal diameter, and is furnished with two sets of points to collect the electricity. For an equal surface of glass the plate machine appears to be the most powerful. In a more

Fig. 5.



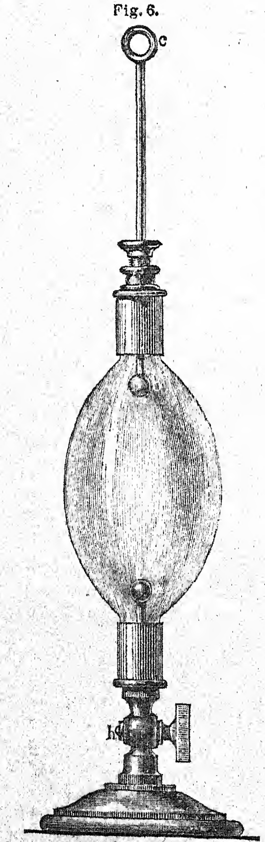
recent form of plate machine, shown in fig. 5, there is but one rubber and flap, occupying a little over a quadrant of the plate. The prime conductor consists of two ring-shaped bodies, *d d*, armed with points and connected with the ball *a*. The rubber is connected with the negative conductor *o*. Whatever advantage the form may have is probably due to the curvature of the surface being greater than that of the ordinary form. The best amalgam for electrical machines is prepared as follows:—One part of zinc and one part of tin are melted together and removed from the fire, and two parts of mercury stirred in. The mass is then placed in a wooden box containing some chalk and well shaken. The amalgam, before it is cold, is powdered in an iron mortar, and preserved in a stoppered glass bottle. For use a little lard is spread over the cushion, and some of the amalgam powder sprinkled over it, and the surface smoothed by a piece of flattened leather. The electrical charge of the machine is restricted to a certain limit, which is attained when the loss of electricity equals its production. The loss depends on three causes, (1) loss by the atmosphere, and the moisture it contains—this is proportional to the density; (2) loss by the supports from leakage; and (3) the recombination of the electricities of the rubbers and the glass.

The electrical charge of the machine increases with the rapidity of the rotation, until it reaches a point at which the tension overcomes the resistance presented by the non-conductivity of the glass. At this point a portion of the two electricities separated on the rubbers and on the glass recombines, and the charge remains constant and independent of the rapidity of rotation.

Holtz's electrical machine depends on the continuous inductive action of a body already charged acting like the electrophorus. By its means enormous quantities of electricity are obtained, comparable to the current yielded by a voltaic cell. In the more recent machine of Winshurst's (fig. 10, Plate XXIV.) two plates rotate horizontally in opposite directions. Each plate has a series of small slips of thin metal foil upon it, which serve as armatures to receive an initial charge from an excited glass rod or an electrophorus. Two uninsulated diagonal conductors are mounted at the front and back, and two insulated collecting combs at the right and left, connected with a discharging apparatus. Each strip of tinfoil is touched by an uninsulated brush as it passes opposite the charged carrier of the other disc, and each thereby has a charge induced in it (as in the case of the electrophorus), which it carries over to the collecting comb on the right or left, and thence to the discharging balls, from which issue a constant stream of sparks.

One of the most remarkable phenomena observed with the electrical machine is the spark drawn from the conductor when the knuckle is presented to it. The spark is instantaneous, and is accompanied by a sharp pricking sensation. It varies in shape; when it strikes at a short distance it is rectilinear. Beyond 2 or 3 inches the spark becomes irregular, and has the form of a sinuous curve with branches (figs. 1-3, Plate XXV.) When the discharge is very powerful it assumes a zigzag form. These two latter appearances are seen in the lightning flash. When a person is insulated by standing upon a stool with glass legs (fig. 4) and touches the prime conductor of the machine, the electricity is distributed over his body, which is a conductor, in the same manner as over an ordinary insulated metallic conductor, and sparks may be drawn from his body. The hair diverges in consequence of repulsion, and a peculiar sensation is felt on the face. A person standing on an insulated stool may be positively electrified by being struck with a cat's skin. In condensed air the light of the spark is white and brilliant, in rarefied air divided and faint, and in highly rarefied air purplish. To illustrate these experiments the annexed apparatus (fig. 6) may be employed, consisting of a glass globe about 4 inches in diameter, provided at each end with a brass cap, to one of which a stopcock, *h*, is screwed, with a wire and ball, *a*, projecting into the globe, and through the other a similar wire, *b c*, slides through a collar of leather, so that the balls may be set at any required distance apart. The apparatus may be exhausted of air by the air-pump, or the air may be condensed in it by a condensing syringe.

Fig. 6.



The phenomena of attraction and repulsion are illustrated by the apparatus termed the electric chimes (fig. 5, Plate XXV.) A series of bells, B B, are suspended to horizontal metal rods in metallic connection with the conductor. A middle bell is insulated from the conductor, but is connected with the earth by means of a chain, c. Between the bells are small metal balls suspended by silk threads. On the bells in connection with the conductor being + electrified they attract the metallic balls, and after contact repel them, being now positively electrified. They are in turn attracted by the middle bell, which is charged with negative electricity by induction; the discharge takes place by the continued ringing of the bells.

If two pieces of tinfoil are fixed, one on each side of a glass plate, and one piece be charged + and the other −, the two charges will attract each other through the glass; and if the glass be set up edgewise, so that neither piece of tinfoil touches any conductor (as in fig. 7), very little discharge is obtained by touching either piece of foil separately; as the charges are acted upon by the force of each other's attraction and inductive action, they are comparatively stable. In this way the two pieces of tinfoil may be charged much more strongly than either piece could be if attached to the glass singly and then electrified. From this circumstance the capacity of a conductor is greatly increased when it is placed near a conductor charged with the opposite kind of electricity, and if its capacity is increased a greater quantity of electricity may be accumulated in it before it is charged to a high potential. Such an arrangement is termed a condenser of electricity. Thus, if two insulated discs, T^1 and T^2 (fig. 6, Plate XXV.), be placed upon opposite sides of a glass plate, and the one (T^1) be connected with the conductor, P C, of an electrical machine, and the other (T^2) to the earth, the + charge upon T^1 will act inductively through the glass plate on T^2, and will repel + electricity into the earth, leaving the side nearest T^1 − electrified. This − charge on T^2 will attract the + charge of T^1 to the side nearest the glass, and a fresh supply is taken up from the conductor of the machine, so that the arrangement becomes an accumulator. If the two metal discs are pushed up close to the glass plate, the attraction becomes stronger between the + and − charges, as the inductive action is greater, and in consequence a still greater quantity can be accumulated in the plates. If, when the discs are thus strongly charged, the connections are removed and the discs are separated from one another, the two charges are not so strongly bound by one another, and there will be more free electrification over their surfaces; and as the capacity of T^1 has diminished by being removed from T^2, the same quantity of electricity now electrifies it to a higher degree than before. Thus the presence of a plate in connection with the earth near an insulated conductor increases its capacity, and enables it to accumulate a greater charge by attracting and storing up the electricity upon the face nearest the earth plate. The stratum of air between the two discs suffices to insulate the two charges from each other. The capacity of a condenser depends upon the size and form of the metal plates or coatings, upon the thinness of the stratum of the dielectric between them, and on the inductive capacity of the dielectric. Glass jars (fig. 8) coated on each side up to a certain height with tinfoil are known as Leyden phials, from having been first constructed at Leyden. A stout wire with a brass knob at the end passes downwards through the lid of dry varnished wood, and communicates by a small loose brass chain attached to

Fig. 7.

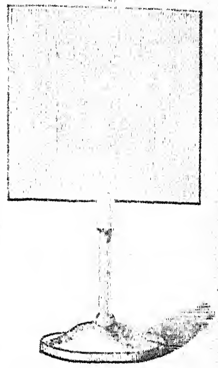
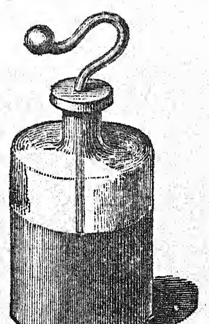


Fig. 8.



STATIC ELECTRICITY.

Fig. 1.

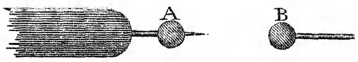


Fig. 2.

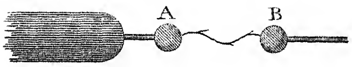


Fig. 3.

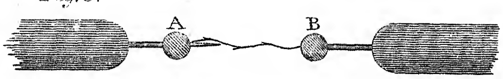


Fig. 5.

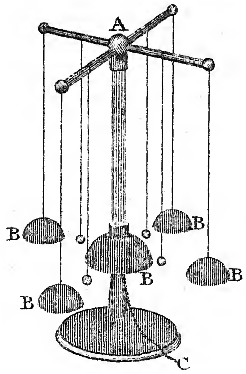


Fig. 7.

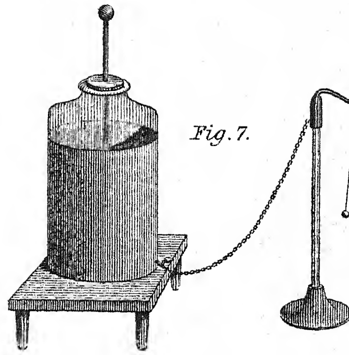


Fig. 4.

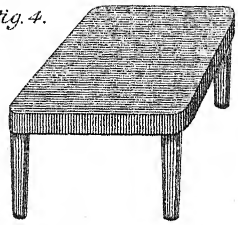


Fig. 6.

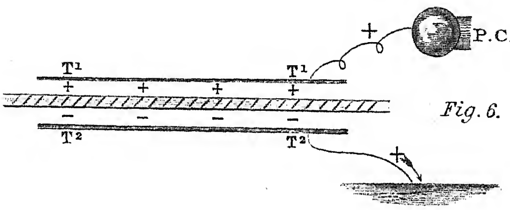


Fig. 8.

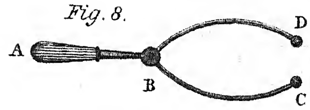


Fig. 9.

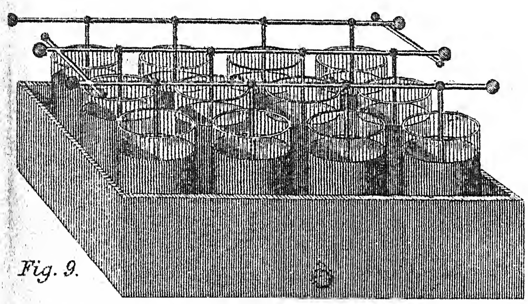
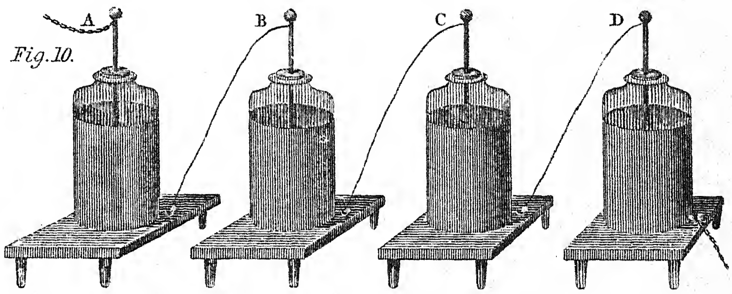


Fig. 10.



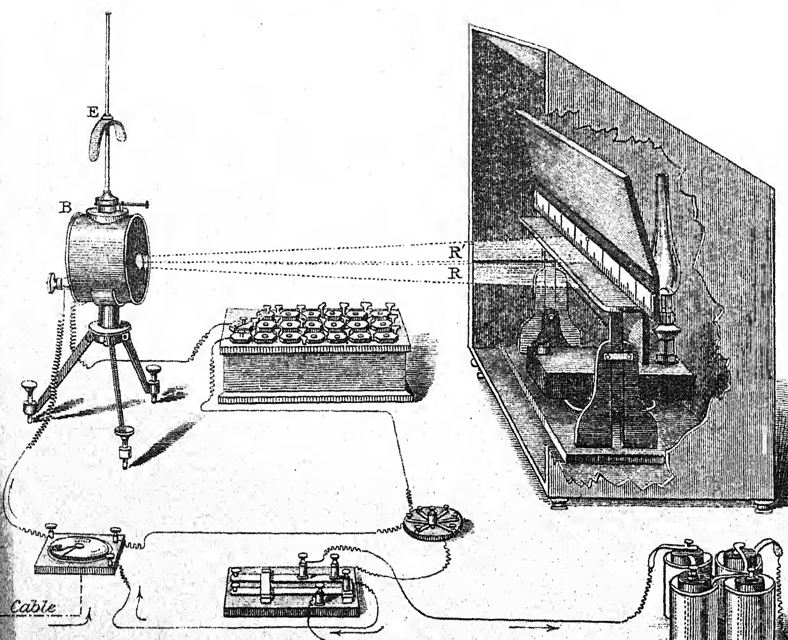


Fig. 11. Mirror or reflecting galvanometer.

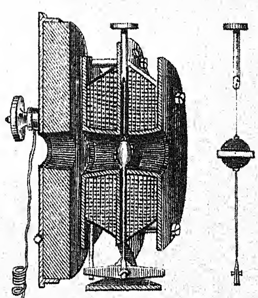


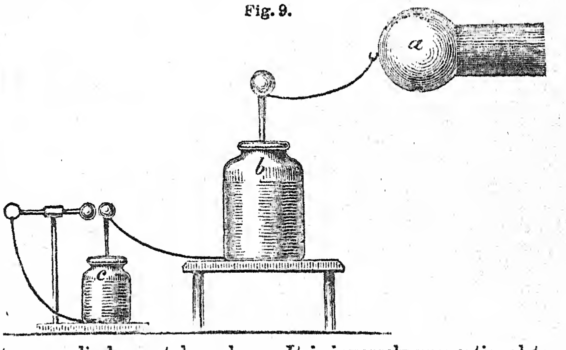
Fig. 12. Section of coil of Thomson's mirror galvanometer, showing the mirror and magnetic needle suspension.

the end with the inner coating of tinfoil. The metallic coatings are called respectively the internal and the external coatings. Like the condenser the Leyden jar is charged by connecting the one coating with the earth and the other with the source of electricity. If when held in the hand, and the external coating is in connection with the earth through the body of the operator, the knob is presented to the + conductor of the machine, + electricity is accumulated in the interior coating, and − electricity on the exterior coating; or if the jar is held by the knob, and the exterior coating is presented to the machine, the reverse takes place. As the + electricity, acting inductively through the glass, decomposes the electricity of the external coating, attracting the − and repelling the + electricity which escapes to the earth by the hand, the action of the Leyden jar is the same as that of the condenser. When the jar has acquired its full charge, the outer coating being − and the inner +, it will retain its charge for some hours, provided it is dry and free from dust, and the quality of the glass is good; but if the two coatings are brought into contact, the two charges will combine instantaneously and the jar be discharged. Thus, when the outer coating is held by one hand, and the knuckle of the other is presented to the brass knob of the interior coating, a bright spark with a sharp snap will pass, and at the same time a smart shock will be felt at the wrists, elbows, and shoulders. The usual mode of discharging the Leyden jar is by the discharger (fig. 8, Plate XXV.), which consists of a brass rod furnished with knobs, C D, joined at B and furnished with a glass handle A. One knob is placed against the outer coating, and the other against the knob of the jar, when the spark between the two knobs discharges the jar. After the jar has been discharged and left for a short time, when the discharger is again used it will be found that a small second discharge spark can be obtained, resulting from what is termed the residual charge; for not only do the electricities adhere to the two surfaces of the insulating medium which separates them, but they penetrate to a certain extent by absorption into the interior. This residue by absorption is greater the longer the jar has remained charged, and is also increased with the amount of the charge. It varies also with the nature of the substance, but with liquids and gaseous insulators there is no residual charge. With paraffin the residue is greatest, shellac less, and with glass and sulphur least; and the amount of residue is found to be nearly proportional to the thickness of the insulator. The return of the residual charge is accelerated by any gentle mechanical action, as tapping the jar with a piece of wood. A Leyden jar constructed of thin glass has a greater capacity as an accumulator than a thick one of the same size; but if the glass is too thin it is destroyed when powerfully charged, by the tension of the opposite electricities culminating in a spark piercing the glass. Toughened glass withstands the strain of tension better than ordinary glass, and Leyden jars made of it can therefore be made thinner and so contain a greater charge. When a very large charge of electricity is required to be accumulated, a series of jars are combined together, as in fig. 10, Plate XXV., all their inner coatings being connected together, and all their external coatings united. Such an arrangement is termed a Leyden battery. Such a battery, to be fully charged, will require a large quantity of electricity, and will produce very powerful effects, so that the greatest caution must be exercised in manipulating arrangements of this nature, as the spark from such a series passing into the body might be fatal. Fig. 9, same Plate, shows a Leyden battery combined as an intensity series.

Franklin discovered that the charges of the Leyden jar do not reside on the metallic coatings, but in reality reside on the surfaces of the glass of the jar. This is conclusively shown by constructing a jar, the interior and exterior coatings of which are removable. If such a jar is placed upon an insulated stand and charged, and the inner coating lifted out by a silk thread, and then the glass jar carefully removed from the outer coating, neither coating will be found to be electrified to any extent, but if the jar is again made up, it will be found to be highly charged as before, the two electricities having remained upon the inner and outer surfaces of the non-conducting glass. The metallic coatings therefore simply act as conductors for distributing the electricity over the surface of the glass, which thus becomes polarized, and retains this state owing to its imperfect conductivity. A more simple experiment may be made by forming a Leyden jar, of which the inside and outside coatings are of mercury, and after charging it, and removing the glass jar, mixing the two mercury coatings and again forming the jar, which may then be discharged.

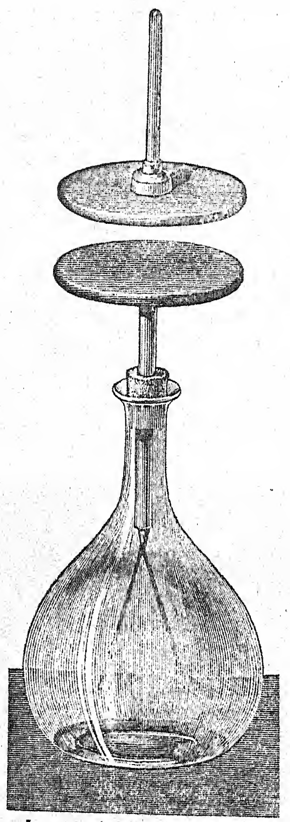
Faraday has shown that the dielectric through which induction takes place plays an important part in the phenomena. All dielectrics through which inductive actions take place are strained, and as a vacuum appears to be a conductor, it follows that it is not the material particles of the dielectric that are thus affected, and this points to the conclusion that electrical phenomena are due to stresses and strains in the ether which pervades all matter and all space. As the particles of bodies are all surrounded by this ether, the strains of the ether are communicated to the particles of the bodies which also suffer a strain. The glass between the two coatings of tinfoil in the Leyden jar is therefore squeezed between the attracting charges of electricity. A Leyden jar, if made of too thin glass, actually gives way under this stress, and when a Leyden jar is discharged, the stratum of air between the knob of the jar and the knob of the discharger is more and more strained as the knobs approach one another, until at last the stress is so great that the layer of air gives way, and is perforated by the spark that discharges itself across. The residual charge of the jar is therefore explained as due to the glass not at once recovering itself from the strain to which it has been subjected. The theory that electric force acts across a space in consequence of the transmission of stresses and strains in the ether with which space is filled, is now generally accepted. The striking distance of the Leyden jar is that at which, when the outer and inner coatings of the Leyden jar are brought gradually nearer each other, a spontaneous discharge takes place. It is inversely proportional to the pressure of the air, and directly proportional to the electric density of that point of the inner coating at which the discharge takes place. As this density at any point of the inner coating is proportional to the whole charge, the striking distance is proportional to the quantity of electricity contained in a jar. The measurement of the charge of a battery by means of the striking distance can only be determined when the charge disappears. Lane's electrometer, constructed on an application of this principle, enables the charge of a jar or battery to be measured. The apparatus consists of a Leyden jar, *c* (fig. 9), near to which is placed a vertical metallic support, carrying at the upper end a brass rod with a knob at one end, and which can be placed in metallic connection with the outside coating of the jar. The rod being movable, the knob can be placed at a measured distance from the knob of the inside coating. The jar *b*, the charge of which is to be measured, is placed on an insulated stand, with its outer coating in metallic connection with the knob and inner coating of the jar *c*, the outer coating of which is in connection with the earth. When the electrical machine is worked, the conductor *a* passes a + charge of electricity into the jar *b*, and a proportionate quantity of − electricity is repelled from its outer coating, and passes into the jar *c*, and there produces a charge. When this has

Fig. 9.



reached a certain tension, it discharges itself between the two knobs, and as often as this takes place an equal amount of + electricity will have passed from the machine into the jar *a*. Hence its charge is proportional to the number of discharges of the electrometer. For small distances, the striking distance is directly proportional to the quantity of electricity, and inversely proportional to the extent of coated surface; that is, it is proportional to the electric density; and when a battery or jar is discharged at the greatest striking distance, the residual charge is always in the same proportion to the entire charge. When a large Leyden jar or battery is discharged by a metallic wire held in the hand, a slight shock is frequently felt; and if the jar be placed on a table, with its knob in contact with the prime conductor, and a chain is stretched on the table, one end nearly touching the outside coating of the jar, when the jar discharges itself a spark is seen to pass between each link of the chain though it forms no part of the circuit. This spark is termed the lateral discharge, and appears to be due to the effects of induction when the electric condition of a neighbouring body is suddenly altered.

Fig. 10.



The contact of two dissimilar metals has been shown by Volta, by means of his condensing electroscope, to produce opposite kinds of electricity on the two surfaces, one being + and the other −. This apparatus (fig. 10) consists of a gold-leaf electroscope in combination with a small condenser. A metallic plate forms the top of the electroscope, on which is placed a second metallic plate provided with a glass handle. The surfaces of the discs are insulated by a coating of shellac varnish. Very small quantities of electricity are rendered sensible by this apparatus. One of the plates is touched with the body under examination, and thus becomes a collecting plate; the other, the condensing plate, is connected with the earth by touching it with the finger. The electricity of the body diffused over the collecting plate, acts inductively through the insulating varnish on the neutral fluid of the other plate, attracting the opposite electricity and repelling that of similar character. The two electricities are thus accumulated on the two plates after the manner of a condenser, but without diverging the gold leaves, as the opposite electricities counteract each other. On raising the upper plate the neutralization is destroyed, and the electricity, being free to move, diffuses itself over the rod and gold leaves, which then diverge. More recent experiments with Sir W. Thomson's delicate mirror electrometers verify Volta's discovery. The differences of electric potential between different pairs of metals is not always equal. Thus zinc and lead are respectively + and − to a slight degree; but zinc and silver are + and − to a much greater degree. The following metals become + electrified when placed in contact in air with those below them in the series.

CONTACT SERIES OF METALS IN AIR.

+Sodium	Tin	Gold
Magnesium	Iron	Platinum
Zinc	Copper	—Gryphite (carbon)
Lead	Silver	

The differences of potential for different pairs of metals have recently been measured by Ayrton and Perry. The following are some of the results:—

	Difference in Volts.
Zinc, Lead,	·210
Lead, Tin.	·069
Tin. Iron,	·313
Iron, Copper,	·146
Copper, Platinum	·238
Platinum, Carbon,	·113

The difference of potential between zinc and carbon is the same as that obtained by adding the successive differences, or 1·09 volts, from which has been determined the following law, known as Volta's law:—That the difference of potential between any two metals is equal to the sum of the differences of potential between the intervening metals in the contact series. It is found that the order of the metals in the contact series in air assimilates very closely with that of the metals arranged in the order of their electro-chemical power, as determined from their chemical equivalents and their heat of combination with oxygen. Therefore the difference of potentials between a metal and the air that surrounds it measures the tendency of that metal to become oxidized by the air. As the air is a bad conductor, while the metals are good conductors, it follows that when two different metals touch they equalize their own potentials by conduction, but leave the films of air that surround them at different potentials. So far all the experiments made have only measured the difference of potentials between the air near one metal and that near another metal, and not between the metals themselves. The theory of the voltaic cell has a most important bearing upon this subject. The contact of two dissimilar liquids with one another likewise produces a difference of potential, and a liquid and a metal in contact also produce a difference of potential. A cold piece of metal in contact with a hot piece of the same metal also produces a difference of potential, electric separation taking place across the surface of contact.

ELECTRIC DISCHARGE.

The recombination of two electricities of high potential is always accompanied by a disengagement of light. The discharge which takes place between two separate conducting surfaces is termed *disruptive*, and the better the conductors on which the electricities are accumulated the more brilliant the spark. Its colour varies both with the nature of the bodies and that of the surrounding medium and with the pressure. Between knobs of wood or ivory, it is crimson; between charcoal points, yellow; between balls of silvered copper, green. In atmospheric air at the ordinary pressure, white; *in vacuo*, violet; in hydrogen, reddish; in vapour of mercury, green; in carbonic acid, green; in nitrogen, blue; and in every case it is accompanied by a peculiar sound. Fusinieri states that the colour of the electric spark is due to the transfer of material particles of matter in a state of extreme tenuity. When the spectrum of the electric spark is obtained it is full of dark lines, the number and arrangement of which depend on the material of which the discharging poles are made. The spark measures the conservative power of the dielectric, as it indicates the limit of the influence which the intervening air or dielectric exerts in resisting discharge; all the effects prior to the discharge being inductive. In every case, the particles, among and across which the discharge suddenly breaks, are displaced, and the path of the spark depends upon the degree of tension acquired by the particles in the line of discharge. The spark may therefore be considered as a discharge or lowering of the polarized inductive state of many dielectric particles by a particular action of a few of the particles occupying a very limited space; all the previously polarized particles returning to their first or normal condition in the inverse order in which they left it, and uniting their powers meanwhile to continue the discharge effect in the place where the subversion of force first occurred.

Wheatstone has shown that the phenomenon of the *brush* discharge consists of successive intermitting discharges, al-

though it appears continuous, and that the sound is due to the recurrence of the noise of each separate discharge, which occurring at intervals nearly equal, causes a definite note to be heard, which, rising in pitch with the increased rapidity of the intermitting discharges, affords a ready and accurate measure of the intervals. The brush is a discharge between a bad or a non-conductor, and either a conductor or another non-conductor. Wheatstone found that the brush discharge generally had a sensible duration, but he could detect no such duration in the spark. Discharge in the form of the brush (see fig. 4) is favoured by rarefaction of the air. It may be obtained not only in air and gases, but also in denser media. The *glow* discharge (fig. 11) takes place when a fine point is used to produce disruptive discharge from a positively charged conductor, a phosphorescent glow covering the end of the wire, and extending a small distance into the air. The glow is always accompanied by a wind proceeding either directly out from the glowing part, or directly towards it, which has been rendered visible by its effects in driving the electric reaction wheel (fig. 9, Plate XXV.) Glow discharge is due to a continuous charge or discharge of air; in the former case accompanied by a current from, and in the latter case by one to, the place of the glow. The glow is assisted by those circumstances which tend to facilitate the charge of the air by the excited conductor, the brush by those which tend to resist the charge of the same, and those which favour intermitting discharge in a more exalted degree favour the production of the spark. Besides being luminous, the electric spark possesses intense heat. When it passes through inflammable liquids, as ether or alcohol, it inflames them. Coal gas may also be ignited by means of the electric spark, as is shown in the case of the "electric pistol," fig. 12, in which an explosive mixture of gas and air is fired in a metallic vessel, D, by means of the insulated conductor A B.

Fig. 11.

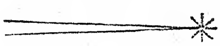
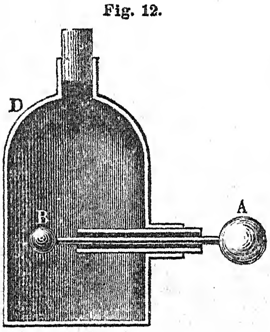
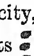
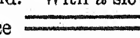
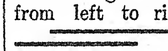
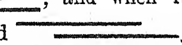
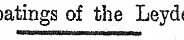
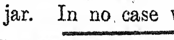


Fig. 12.



The discharge of the Leyden jar is effected with a velocity so enormous that it may be regarded as momentary. Wheatstone has measured this velocity, and shown it to greatly exceed that of light itself. It is, in fact, so great that the most rapid motion that can be produced appears to be actual rest. A wheel on which a five pound note is affixed, revolving with a rapidity sufficient to render it invisible, when illuminated by a flash of electricity is seen for an instant with the wording of the note quite distinct—because, however rapid the rotation may be, the light has come and already ceased before the wheel has had time to turn through a sensible space; vibrating strings are seen at rest in their deflected positions; and a rapid succession of drops of water, appearing to the eye a continuous stream, is seen to be what it really is. Wheatstone viewed the image of a spark reflected from a plane mirror, which, by means of a train of wheels, was kept in rapid rotation on a horizontal axis. The number of revolutions performed by the mirror was ascertained, by means of the sound of a siren connected with it, to be 800 in a second, during which time the image of a stationary point would describe 1600 circles, as, from the laws of reflection, the image of a luminous point describes an arc of double the number of degrees which the mirror describes, in the time in which the mirror passes from the position in which the image is visible to that in which it ceases to be so. If the duration of the image were absolutely instantaneous the arc would be reduced to a mere point. Knowing the number of turns which the mirror makes in a second, and measuring, by means of a divided circle the number of degrees occupied by the image, the duration of the spark was determined. In one experiment this arc was 24 degrees, and as the mirror made 800 turns in a second the image traversed 576,000 degrees in the same time, and as the arc was 24 degrees the image lasted the $\frac{24}{576000}$ or $\frac{1}{24000}$ of a second. The discharge is therefore not instantaneous. When greater resistances are interposed in the circuit through which the discharge is effected, the duration of the spark is increased. The duration also increases with the striking distance, and with the dimensions of the battery. To determine the velocity of electricity, Wheatstone constructed an apparatus termed a spark board. Six insulated metal knobs were arranged in a horizontal line on a piece of wood. Knob 1 was connected with the inner coating of a Leyden jar; knob 2 was a tenth of an inch distant from knob 1; between knobs 2 and 3 a quarter of a mile of insulated wire was interposed; knob 3 was also a tenth of an inch from knob 4, and between knobs 4 and 5 a second quarter of a mile of wire was interposed; lastly, knob 5 was a tenth of an inch from knob 6, from which a wire led directly to the outer coating of the Leyden jar. Hence, when the jar was discharged, sparks would pass between 1 and 2, between 3 and 4, and between 5 and 6; and the discharge has to pass in its course through a quarter of a mile of wire between the first and second spark, and through a second quarter of a mile between the second and third spark. The spark board was arranged at a distance of 10 feet from the revolving mirror. If the mirror was at rest, or only had a small velocity, the image of the three sparks would be seen as three dots ; but when the mirror had a certain velocity these dots appeared as lines, which became longer as the velocity increased. The greatest elongation observed was 24 degrees, indicating a duration of about the 24,000th part of a second. With a slow rotation the lines presented the appearance  being quite parallel, and the ends in the same line; but with a higher velocity, and when the rotation took place from left to right, the lines assumed the appearance , and when it was from right to left they appeared , because the image of the central spark was formed after the lateral ones. Wheatstone measured this displacement to amount to half a degree before or behind the others, which corresponded to a duration of $\frac{1}{2 \times 720 \times 100}$ or $\frac{1}{1152000}$ of a second; the space traversed in the time being a quarter of a mile, giving for the velocity of electricity 288,000 miles in a second, light travelling with a velocity of 196,000 miles in a second. As the images of the two outer sparks appeared simultaneously in the mirror, it follows that the electric current issues simultaneously from the two coatings of the Leyden jar. In no case were the sparks seen  or , as required by the hypothesis of a single fluid. The velocity of dynamical electricity is considerably less, and on account of induction the transmission of a current through submarine wires is comparatively slow. In insulated wires the velocity is greater in air than in water. The nature of the conductor has considerable influence on the velocity; but not the thickness of the wire, nor the potential of the electricity.

The atmosphere is the region in which the electricity liberated by the different processes of nature accumulates, and it is found there in different degrees of intensity, and also varying in its condition, being sometimes + and at other times −. With a clear air and calm sky the electricity is generally +. In damp and rainy weather it is more frequently −. Lightning is the process by which nature disposes from time to time of an excess of that electricity which is required for the purpose of carrying on the process of vegetation, and also animal life. The analogy between the electric spark and lightning was noticed at an early period of electrical science. Lightning and thunder are atmospheric electrical phenomena, the result of an electrical disturbance arising from the accumulation of active electricity in masses of vapour in the form of clouds, condensed

in the atmosphere. From the laws of induction a mass of electrified vapour determines an opposite electrical state over that portion of the earth's surface directly opposed to it, the particles of intervening air become polarized; and when the tension has been raised to a certain point, and the particles can no longer resist the tendency of the opposite electrical forces to combine, they are displaced and broken through with a greater or less degree of mechanical violence. The clouds and the earth, or two oppositely electrified clouds, correspond to the coatings, and the intervening air to the glass of the Leyden phial, and the thunderstorm is the discharging of this huge system. The equilibrium of the clouds is sometimes restored by a single flash of lightning; at other times the accumulation is so immense and the neighbouring strata of air so strongly charged that the flashes continue for hours before they culminate in a storm of rain. A person may be killed by lightning although the flash may have taken place 20 miles off, by what is termed the back stroke. When the two extremities of a cloud highly charged hang down to the earth they will repel the electricity from the earth's surface if it be of the same kind as their own, and will attract the opposite kind; if a discharge should suddenly take place at one end of the cloud the equilibrium will instantly be restored by a flash at that point of the earth which is under the other. This back stroke, though often sufficiently powerful to destroy life, is never so violent in its effects as the direct shock.

In the selection of a lightning conductor preference should be given to copper; the upper extremity should be divided into three or four points, and the lower end should be formed into a large coil, and penetrate the earth sufficiently deep to be in close contact with moist soil, or with a spring of water. The conductor should be carried above the highest point of the building. Every part of the conducting rod should be perfectly continuous. The conductor should be affixed as closely as possible to the walls of the building, and in direct contact with them, to insure a perfect earth connection; and all contiguous masses of metal, such as gutters, lead roofing, water-pipes, &c., should be metallically connected with it.

ARITHMETIC.—CHAPTER XIII.

COMPUTATION OF COMPOUND QUANTITIES, MONEY, WEIGHTS, MEASURES, &c.

COMPOUND MULTIPLICATION consists in finding the product of a given compound quantity by any proposed simple figurate number (*i.e.* a number taken as abstract, not as concrete). Problems in compound multiplication may be most simply arranged in four classes—

1. *When the multiplier does not exceed* 12. In this case set the multiplier under the lowest division of the given compound quantity, and multiply each of the several denominations from *right* to *left*, in succession, by the given multiplier. If the product arising from any of these separate acts of multiplication reaches a number which brings the amount of it up to or above the quantity contained in the denomination next above it, divide the product found by the number of the less denomination which make one of the higher, and having set down the remainder in the less denomination, carry, as in addition, the quotient to the next. Now multiply the second denomination by the multiplier, add in the quotient carried, and proceed as before till the whole is finished, as—

(1)				(2)				(3)			
£15	11	$8\frac{3}{4}\times 8$		£19	5	$7\frac{1}{4}\times 11$		£13	5	$4\frac{3}{4}\times 12$	
		8				11				12	
124	13	10		212	1	$7\frac{3}{4}$		159	4	9	

Thus, in the first example we say, $8\times 3=24\div 4=6$; $8\times 8=64+6$ carried $=70\div 12=5s.\ 10d.$ Of these we put down the latter in the answer and the former we carry; $8\times 11=88+5=93s.\div 20=£4\ 13s.$ Put 13*s.* down as part of the answer and proceed; $8\times 15=120+4$ carried $=£124$, giving the answer as shown. The others are worked in precisely the same way.

2. *When the multiplier consists of a number the component parts of which do not exceed* 12. Multiply by the component parts of the multiplier in succession, as—

Required the product of £27 13*s.* $11\frac{1}{4}d.$ by 16.

(1)			(2)			(3)		
£27	13	$11\frac{1}{4}$	£27	13	$11\frac{1}{4}$	£27	13	$11\frac{1}{4}$
		2			4			8
55	7	$10\frac{1}{2}$	110	15	9	221	11	6
		8			4			2
443	3	0	443	3	0	443	3	0

3. *When the multiplier is a prime number.* Take the component parts of the nearest composite number to the multiplier, either greater or less, multiply by each of these component parts in succession, and then multiply the multiplicand by the difference between the composite number assumed and the multiplier; add this product to, or subtract it from, that resulting from the use of the composite number, according as that has been taken greater or less than the given multiplier, as—

Multiply £11 7*s.* $10\frac{3}{4}d.$ by 23.

(1)					(2)				
£11	7	$10\frac{3}{4}$			£11	7	$10\frac{3}{4}$		
		2					6		
22	15	$9\frac{1}{2}$			68	7	$4\frac{1}{2}$		
		11					4		
250	13	$8\frac{1}{2}$	prod.	by 22.	273	9	6	prod.	by 24.
11	7	$10\frac{3}{4}$	"	by 1.	11	7	$10\frac{3}{4}$	"	by 1.
262	1	$7\frac{1}{4}$	"	by 23.	262	1	$7\frac{1}{4}$	"	by 23.

(3)					(4)				
£11	7	$10\frac{3}{4}\times 11$			£11	7	$10\frac{3}{4}\times 11$		
		12			125	6	$10\frac{1}{4}$	prod.	by 11.
136	14	9	prod.	by 12.	125	6	$10\frac{1}{4}$	"	by 11.
125	6	$10\frac{1}{4}$	"	by 11.	262	1	$7\frac{1}{4}$	"	by 23
262	1	$7\frac{1}{4}$	"	by 23.					

4. *When the multiplier is large, extending to three, four, or more figures,* multiply by 10 for each figure in the multiplier, except that of the units, then multiply the multiplicand or top line by the unit figure of the multiplier, the first product by the tens figure of it, the second product by the hundreds, the third product by the thousands, and so on; set all these products to the right of the former, and their sum is the complete product.

Multiply £629 17*s.* 8*d.* by 15685.

Here we have four figures before that of the units' place. Hence we multiply four times by 10. After this we multiply each respective line by the figures as they proceed from right to left, that is, from units onwards.

£	*s.*	*d.*		Partial Products. £	*s.*	*d.*
629	17	8	$\times 5=$	3149	8	4
		10				
6298	16	8	$\times 8=$	50390	13	4
		10				
62988	6	8	$\times 6=$	377930	0	0
		10				
629883	6	8	$\times 5=$	3149416	13	4
		10				
6298833	6	8	$\times 1=$	6298833	6	8
			Total,	9879720	1	8 *Ans.*

COMPOUND DIVISION is the converse of multiplication, and the one forms the best proof of the other. Set the divisor on the left of the dividend, and divide the highest denomination. If there is any remainder, reduce that to the next lower denomination, multiplying it by the proper number of

that denomination, as in descending reduction, and add in the given term of this lower denomination. Divide again, and proceed in the same manner till the entire quotient is found. If the divisor is small, employ the short process of division; if the divisor is large, employ the long process.

Divide £743 11*s.* 7*d.* by 8.

	£	s.	d.			£	s.	d.
8)	743	11	7		Proof:	92	18	$11\frac{1}{4} + 4$
	92	18	$11\frac{1}{4} + 4$					8
						743	11	7

The division of 743 by 8 goes on as in simple division. This done we have a remainder of £7 = 140*s.* To this we add the 11*s.* in the account. This gives us 151*s.* Divided by 8 this gives as answer 18*s.*, with 7*s.* of a remainder; $7s. \times 12 + 7 = 91d.$ This divided by 8 yields 11*d.*, with 3*d.* left over. $3 \times 4 = 12$, and $12 \div 8 = \frac{1}{4}\ \frac{1}{2}$. In the reverse process of proof we multiply. Eight half-farthings are equivalent to four farthings. Eight farthings and four farthings make threepence. Then $11 \times 8 + 3 = 91$ [*i.e.* 7*s.* 7*d.*]; $18 \times 8 + 7 = 151$ [*i.e.* £7 11*s.*]; $92 \times 8 + 7 = 743$; total, £743 11*s.* 7*d.*

The following are specimens of the work—(1) When the number is prime; and (2) When the divisor is large, and not capable of being reduced to component parts, viz.:—

Divisor.	Dividend.			Quotient.				Proof.
	£	s.	d.	£	s.	d.		
(1) 17)	5764	19	$5\frac{1}{2}$(	339	2	$3\frac{3}{4} \times 8$		
	51			2712	18	6	prod. by 8.	5764 19 $5\frac{1}{2}$
	66			2712	18	6	prod. by 8.	
	51			0	0	$1\frac{3}{4}$	rem.	
	154							
	153							
	1							
	20							
	39, &c.							

	£	s.	d.	£	s.	d.
(2) 137)	629	17	$8\frac{3}{4}$(	4	11	$11\frac{1}{4}$
	548					
	81					
	20					
	1637, &c.					

The following are the tables of various measures now recognized and legalized. Of these, as of the money tables, the student should acquire an accurate and ready knowledge. Precisely the same rules as have been given for the management of computations in money, must be followed in dealing with these measures in all the four primary operations, and in reduction. There is no difference in method, though there is in the order, and consequently in the system of carriage of the units; but, knowing the order of the units—that is, how many of one denomination make a unit of the next higher denomination—there exists no more difficulty in working these compound quantities than in finding the sum of a like account in simple numbers.

MEASURE OF WEIGHT.

Avoirdupois Weight.

$27\frac{11}{32}$	Grains	= 1 Drachm	
16	Drachms	= 1 Ounce	= $437\frac{1}{2}$ grains.
16	Ounces	= 1 Pound (lb.)	= 7000 "
28	Pounds	= 1 Quarter (qr.)	
4	Quarters	= 1 Hundredweight (cwt.)	
20	Cwts.	= 1 Ton.	

This measure is used in almost all commercial transactions, and in the common dealings of life. The Troy pound is less than the avoirdupois, in the proportion of 144 to 175; but the Troy ounce is greater than the avoirdupois, as 72 to 79 nearly.

Troy Weight.

24 Grains	=	1 Pennyweight (dwt.)
20 Dwts.	=	1 Ounce = 480 grains
12 Ounces	=	1 Pound = 5760 "

These denominations of Troy weight are used for weighing gold, silver, and precious stones (except diamonds). Troy weight is also used by apothecaries in compounding medicines, and by them the ounce is divided into 8 drachms, and the drachm into 3 scruples, so that the scruple is equal to 20 grains. For scientific purposes the grain only is used.

MEASURE OF LENGTH.

12	Inches	=	1 Foot
3	Feet	=	1 Yard
$5\frac{1}{2}$	Yards	=	1 Rod or Pole
40	Poles	=	1 Furlong
8	Furlongs or 1760 yds.	=	1 Mile
$69\frac{1}{21}$	Miles	=	1 Degree of a Great Circle of the Earth.

An inch is the smallest lineal measure to which a name is given, but subdivisions are used for many purposes. Among mechanics *eighths*, and by scientific persons *tenths*, *hundredths*, &c.

Particular Measures of Length.

A Nail	=	$2\frac{1}{4}$	Inches	used for measuring cloth of all kinds.
Quarter	=	4	Nails	
Yard	=	4	Quarters	
Ell	=	5	Quarters	
Hand	=	4	Inches	for height of horses.
Fathom	=	6	Feet	in measuring depths.
Link	=	7	In. 92 hdths.	in land measure to facilitate computation of the content, 10 sq. chains = an acre.
Chain	=	100	Links.	

MEASURE OF SURFACE.

144	Square Inches	=	1 Square Foot
9	Square Feet	=	1 Square Yard
$30\frac{1}{4}$	Square Yards	=	1 Perch or Rod
40	Perches	=	1 Rood
4	Roods	=	1 Acre
640	Acres	=	1 Square Mile

MEASURE OF SOLIDITY.

1728 Cubic Inches	=	1 Cubic Foot
27 Cubic Feet	=	1 Cubic Yard

SOLID MEASURE OF CAPACITY.

5 Ounces	= 1 Gill			
4 Gills	= 1 Pint	=	$34\frac{2}{3}$	cubic inches nearly.
2 Pints	= 1 Quart	=	$69\frac{1}{3}$	"
4 Quarts	= 1 Gallon	=	$277\frac{1}{4}$	"
2 Gallons	= 1 Peck	=	$554\frac{1}{2}$	"
8 Gallons	= 1 Bushel	=	$2218\frac{1}{5}$	"
8 Bushels	= 1 Quarter	=	$10\frac{1}{4}$	cubic feet nearly.
5 Quarters	= 1 Load	=	$51\frac{1}{3}$	"

The first four denominations are used for liquids; the last four for dry goods.

ANGULAR MEASURE, OR DIVISIONS OF THE CIRCLE.

60 Seconds	= 1 Minute
60 Minutes	= 1 Degree
30 Degrees	= 1 Sign
90 Degrees	= 1 Quadrant
360 Degrees, or 12 Signs	= 1 Circumference

MEASURE OF TIME.

60 Seconds	= 1 Minute
60 Minutes	= 1 Hour
24 Hours	= 1 Day
7 Days	= 1 Week
28 Days	= 1 Lunar Month
28, 29, 30, or 31 Days	= 1 Calendar Month
12 Calendar Months	= 1 Year
365 Days	= 1 Common Year
366 Days	= 1 Leap Year

In 400 years, 97 are leap and 303 common years.

METRIC OR DECIMAL SYSTEM OF WEIGHTS AND MEASURES.

The *metric* system of weights and measures, by its simplicity and convenience, has commended itself for use in commercial transactions and scientific work of all kinds. Its *basis* is the fourth part of a meridian of the earth. Of this, the *ten-millionth part* is taken as the unit of lineal measure, namely, a *mètre.* The *cube* of a mètre is the unit of measure of capacity, that is, a *litre.* The thousandth part of the weight of a litre of distilled water (taken at its greatest density, *i.e.* 40° Fahr. or 4° C.), under the name of *gramme*, is the unit of weight. A surface of 10 mètres each way (*i.e.* 100 square mètres) is called an *are*, and is the unit of superficial measure. The principle of nomenclature adopted was to employ terms derived from the Greek numerals—*deca* = 10; *hecaton* = 100; *kilioi* = 1000; *myrioi* = 10,000 times—to indicate multiples, and the Roman numerals to denote subdivisions—*decimus* = 10ths; *centesimus* = 100ths; *millesimus* = 1000ths.

The following tables are so arranged that in each column *descending* the multiples by tens are exhibited, while each column *ascending* shows the result of division by tens. The tables read from left to right give the results of divisions made by the number of the left-hand column contained in the several quantities proceeding to the right; and proceeding from right to left the results of multiplication in the same way. The student, on referring to our instructions on the method of working decimals (pp. 891–93 and 992–95) will have no difficulty in applying these to any question which may arise in ordinary computation, and thorough working of the several elements in the tables will be found to supply an excellent praxis in the reduction of English into French measures, and *vice versâ.*

MEASURE OF LENGTH (UNIT, THE METRE).

Equal to English	Inches.		Feet.		Yards.		Fathoms.		Miles.
Millimètre (mm.),	0·03937	...	0·003281	...	0·0010936	...	0·0005468	...	0·0000006
Centimètre (cm.),	0·39371	...	0·032809	...	0·0109363	...	0·0054682	...	0·0000062
Décimètre (dm.),	3·93708	...	0·328090	...	0·1093633	...	0·0546816	...	0·0000621
Mètre,	39·37079	...	3·280899	...	1·0936331	...	0·5468165	...	0·0006214
Décamètre (dm.),	393·70790	...	32·808992	...	10·9363306	...	5·4681653	...	0·0062138
Hectomètre (hm.),	3937·07900	...	328·089917	...	109·3633056	...	54·6816528	...	0·0621382
Kilomètre (km.),	39370·79000	...	3280·899167	...	1093·6330556	...	546·8165278	...	0·6213824
Myriamètre (mm.),	393707·90000	...	32808·991667	...	10936·3305556	...	5468·1652778	...	6·2138242

CUBIC MEASURE, OR MEASURE OF CAPACITY (UNIT, THE LITRE).

Equal to English	Cubic Inches.		Cubic Feet.		Pints.		Gallons.		Bushels.
Millilitre, or cubic centimètre,	0·06103	...	0·000035	...	0·00176	...	0·0002201	...	0·0000275
Centilitre, 10 cubic centimètres,	0·61027	...	0·000353	...	0·01761	...	0·0022010	...	0·0002751
Décilitre, 100 cubic centimètres,	6·10271	...	0·003532	...	0·17608	...	0·0220097	...	0·0027512
Litre (*i.e.* cubic décimètre),	61·02705	...	0·035317	...	1·76077	...	0·2200967	...	0·0275121
Décalitre, or centistère (dl.),	610·27052	...	0·353166	...	17·60773	...	2·2009668	...	0·2751208
Hectolitre, or décistère (hl.),	6102·70515	...	3·531658	...	176·07734	...	22·0096677	...	2·7512085
Kilolitre, or stère (*i.e.* cub. mèt.), kl.	61027·05152	...	35·316581	...	1760·77341	...	220·0966767	...	27·5120846
Myrialitre, or décastère (ml.),	610270·51519	...	353·165807	...	17607·73414	...	2200·9667675	...	275·1208459

MEASURE OF WEIGHT (UNIT, THE GRAMME).

Equal to English	Grains.		Troy Oz.		Avoirdupois Lbs.		Cwt. = 112 lbs.		Ton = 20 cwts.
Milligramme (mg.),	0·01543	...	0·000032	...	0·0000022	...	0·0000000	...	0·0000000
Centigramme (cg.),	0·15432	...	0·000322	...	0·0000220	...	0·0000002	...	0·0000000
Décigramme (dg.),	1·54323	...	0·003215	...	0·0002205	...	0·0000020	...	0·0000001
Gramme	15·43235	...	0·032151	...	0·0022046	...	0·0000197	...	0·0000010
Décagramme (dg.),	154·32349	...	0·321507	...	0·0220462	...	0·0001968	...	0·0000098
Hectogramme (hg.),	1543·23488	...	3·215073	...	0·2204621	...	0·0019684	...	0·0000984
Kilogramme (kg.),	15432·34880	...	32·150727	...	2·2046213	...	0·0196841	...	0·0009842
Myriagramme (mg.),	154323·48800	...	321·507267	...	22·0462126	...	0·1968412	...	0·0098421

SQUARE MEASURE, OR MEASURE OF SURFACE (UNIT, THE ARE).

Equal to English	Sq. Feet.		Sq. Yards.		Sq. Perches.		Roods.		Acres.
Centiare, square mètre (cmq.),	10·764299	...	1·196033	...	0·0395383	...	0·0009885	...	0·0002471
Are, 100 square mètres,	1076·429934	...	119·603326	...	3·9538290	...	0·0988457	...	0·0247114
Hectare, 10,000 sq. mètres (hmq.),	107642·993419	...	11960·332602	...	395·3828959	...	9·8845724	...	2·4711431

The student will now carefully examine the following summations, referring regularly for the value of each order of units in relation to the other to the tables already given:—

Tons	cwt.	qr.	lb.	oz.	dr.
21	15	3	12	11	14
17	19	2	15	15	12
5	3	1	0	12	3
31	0	3	21	11	15
24	11	0	17	4	10
11	18	2	27	15	11
112	9	2	12	8	1

Lb.	oz.	dwt.	gr.
34	1	19	21
145	10	11	18
217	9	17	11
58	11	5	15
352	7	12	12
79	0	18	10
888	6	5	15

Mls.	fur.	p.	yd.	ft.	in.
21	3	35	4	2	10
7	7	16	3	1	9
16	5	4	2	0	6
32	0	29	5	2	7
19	6	14	1	2	8
6	4	31	0	1	3
104	4	12	3	2	7

Ac.	rd.	p.	yd.	ft.	in.
17	3	37	15	8	91
5	1	25	28	6	126
12	2	30	30	7	19
0	3	16	15	3	7
34	0	39	24	0	140
7	3	4	7	5	18
78	3	35	4	4	113

As the operative difficulty of carrying is somewhat troublesome until fully understood, we supply a key to the first of the following accounts in subtraction. The second may readily be worked without help.

E.	D.	C.	B.	A.
4 tons	8 cwt.	2 qr.	21 lb.	13 oz.
2 tons	17 cwt.	0 qr.	25 lb.	14 oz.
1 ton	11 cwt.	1 qr.	23 lb.	15 oz.

Mile	fur.	p.	yd.	ft	in.
17	5	15	5	1	3
9	6	21	5	1	5

Seeing that 14 cannot be taken from 13, we *borrow* 16 (that is, 1 of B), and for readiness subtract the 14 from that number; this leaves 2, which added to 13 gives 15 as the remainder under A. We next *carry* 1 to 25, and observing that 26 cannot be subtracted from 21, we *borrow* 28 (that is, 1 of C), and subtracting 26 from that number, we obtain a remainder of 2, which we add to 21, making 23 as the remainder to be set down under column B. Carrying 1 to 0 of C in the under line, and subtracting, we get 1 as the remainder to be set down in that column. Under D, as we cannot take 17 from 8, we *borrow* 20 (that is, 1 of E), and subtracting 17 from that number, we have 3 to be added to 8, making

11 as the remainder to be set down, and carrying 1 to 2 of E, and subtracting, we get 1 for the remainder to be there set down.

Multiply 13 lb. 12 dwt. 14 gr. by 13.

Lb.	oz.	dwt.	gr.	
13	0	12	14	× 12
156	7	11	0	prod. by 12.
169	8	3	14	prod. by 13.

Lb.	oz.	dwt.	gr.	
13	0	12	14	× 6
				7
91	4	8	2	prod. by 7.
78	3	15	12	prod. by 6.
169	8	3	14	prod. by 13.

Divide £321 9*s.* $2\frac{1}{4}$*d.* by the composite number 18.

	£	s.	d.	
3 × 6 = 18.	3)321	9	$2\frac{1}{4}$	
	6)107	3	$0\frac{3}{4}$	
Quotient,	17	17	$2\frac{1}{8}$	*Ans.*
			9	
	160	14	$7\frac{1}{8}$	
	160	14	$7\frac{1}{8}$	
Proof,	321	9	$2\frac{1}{4}$	

	£	s.	d.	
9 × 2 = 18.	9)321	9	$2\frac{1}{4}$	
	2)35	14	$4\frac{1}{4}$	
Quot.,	17	17	$2\frac{1}{8}$	*Ans.*
			3	
	53	11	$6\frac{3}{8}$	
			6	
Proof,	321	9	$2\frac{1}{4}$	

EXERCISES.

1. *Reduction—*

£12 make how many farthings? *Ans.* 11520.
6169 pence equal how many pounds? *Ans.* £25 14*s.* 1*d.*
35 guineas are worth how many farthings? *Ans.* 35280.
In 46751 guineas, how many pounds? [× 21 ÷ 20.]
£49088 11*s.* are worth how many guineas? [× 20 ÷ 21.]

2. *Addition—*

£	s.	d.		£	s.	d.		£	s.	d.
173	13	5		705	17	$3\frac{1}{2}$		1275	12	4
87	17	$7\frac{3}{4}$		354	17	$2\frac{3}{4}$		700	10	$10\frac{1}{2}$
75	18	$7\frac{1}{2}$		175	17	$3\frac{3}{4}$		25	13	$3\frac{3}{4}$
25	17	$8\frac{1}{4}$		87	19	$7\frac{1}{2}$		5	17	$7\frac{3}{4}$
10	10	$10\frac{1}{2}$		52	12	$7\frac{3}{4}$		0	18	8
2	5	7		27	10	$5\frac{1}{4}$		0	17	0
376	3	10 *Ans.*		1404	14	$6\frac{1}{2}$ *Ans.*		2009	9	10 *Ans.*

3. *Subtraction—*

£	s.	d.		£	s.	d.		£	s.	d.
284	9	8		474	0	$6\frac{1}{4}$		1097	14	$7\frac{3}{4}$
192	19	3		72	17	$7\frac{1}{2}$		596	12	$9\frac{1}{2}$
91	10	5 *Ans.*		401	2	$10\frac{3}{4}$ *Ans.*		501	1	$10\frac{1}{4}$ *Ans.*

(4) *Multiplication—* (5) *Division—*

£	s.	d.			£	s.	d.	
0	12	$10\frac{1}{4}$	× 37		23	15	$7\frac{1}{4}$	÷ 37
3	15	2	× 53		199	3	10	÷ 53
4	17	11	× 138		675	12	6	÷ 138
0	17	$3\frac{1}{4}$	× 365		315	3	$10\frac{1}{2}$	÷ 365

1 ton 12 cwt. 1 qr. × 7. *Ans.* 11 tons 5 cwt. 3 qr.
5 cwt. 3 qr. 16 lb. × 10. *Ans.* 58 cwt. 3 qr. 20 lb.
8309 lb. 11 oz. 2 gr. ÷ 579. *Ans.* 14 lb. 4 oz. 4 dwt. $12\frac{350}{579}$ gr.
6870 miles 7 fur. 2 yds. ÷ 705. *Ans.* 9 miles 5 fur. $212\frac{194}{235}$ yds.
4937 yds. 3 qrs. 3 nls. ÷ 874. *Ans.* 5 yds. 2 qrs. $2\frac{347}{874}$ nls.

THE LATIN LANGUAGE.—CHAPTER XIV.

SYNTAX—LATIN USAGES IN REGARD TO VERBS—LESSON IN READING, WITH ANNOTATIONS.

In our previous chapter we explained the chief syntactical phenomena of case, and gave such information as should have enabled the student, on seeing any noun before him, to determine the case, and perceive the reason why that noun occurs in that special case. We shall now endeavour to determine the laws which regulate the changes which take place in verbs. The word *law*, as here used, does not denote an imperative and undeviating necessity, exercising compulsory power over the operations of mind or language (or both), but is employed rather to indicate the generalized inductions of grammarians acquired by careful observation of the modes of expression employed by the best minds in using a language. They are guides to us in the study of a language, because they present to us in brief, clear statement the facts which scholars have observed, registered, and classified. In Latin, as in every other language, the tastes of authors—their modes of thinking and manner of writing—differ, and therefore there are numerous peculiarities and felicities of style which distinguish special authors. In prose writing some classical scholars prefer the vocabulary and constructions of Cæsar, Sallust, Livy, or Tacitus, while others will tolerate nothing unless it have the Ciceronian fluency and swell. Not only do specialties prevail in poetry, but men have acquired likings for the power and beauty of Lucretius, the lustrous rhetoricality of Ovid, the ornate majesty of Virgil, or the good-humoured versatility of Horace. These differing tastes and likings influence their ideas of composition, and they, of course, notice and note most carefully the forms of construction mostly used by their favourite authors. These sometimes lead to variations in the statement of distinct points; but, upon the whole, a general *consensus* has been reached regarding the great main requirements of Latin composition, and these are most commonly presented to the student in the form of rules.

It ought to be distinctly understood that a large proportion of the specialties, delicacies, &c., and much of the finesse of construction, are the results of difference, (1) in habit of thought between the Romans and the moderns, (2) in the capacities of the language and the requirements of the people, and (3) in the peculiarities of individual writers or of the subjects on which they write. Therefore to understand, apply, or employ a rule properly, we must endeavour to get at the thought which regulated the expression, by accustoming ourselves to think in the Roman fashion.

SECTION I.—CONCORD OF VERBS WITH NOMINATIVES.

The verb which forms the predicate in a sentence must agree (1) in number, (2) in person, and (3)—if any part of the verb is used in which participles occur—in gender, with the subject, whether that is expressed by (1) a noun, (2) a pronoun, (3) an adverb with a genitive case, (4) an infinitive mood, or (5) a part of a sentence—indicated by or implied in the general sense of the sentence, or left undefined, as it is in the case of impersonal verbs.

Puer ludit,	*The boy is playing.*
Pueri ludunt,	*The boys play.*
Ego rogo,	*I ask.*
Tu narras,	*Thou tellest.*
Monitus sum [or fui],	*I have been advised.*
Divisi sumus [or fuimus],	*We have been divided.*
Ego, regina, spretæ sum [or fui],	*I, the queen, have been despised.*
Viri occisi sunt,	*Men have been slain.*
Feminæ occisæ sunt,	*Women have been slain.*
Sera nunquam est ad bonos mores via,	*The way to good manners is never too late.*
Fertur atrocia flagitia designasse,	*It is said that he* (or *he is said to have*) *committed horrid crimes.*
Partim virorum ceciderunt in bello,	*Part of the men fell in the war.*
Ego et tu [jointly equivalent to *nos*] sumus in tuto,	*I and you are in safety.*
Non est jocus, esse malignum,	*It is not wit to be malicious.*
Caput artis est, decere quod facias,	*The essence of art is, that what you do should be appropriate.*
Pio mori est nasci.	*To the pious death is birth.*

A verb, placed between two subjects [*i.e.* nominatives] of different numbers, may agree with either (but generally does so with the nearer of the two); as,

Captivi militum præda facti sunt.	*The captives were made the booty of the soldiery.*
Amantium iræ amoris redintegratio est,	*The quarrels of lovers is the renewing of love.*
Pectus quoque robora fiunt.	*The breast also becomes oak.*

A noun of multitude having a singular termination is sometimes joined to a plural verb; as, *Pars abiere*, Part are gone away; *Uterque deluduntur dolis*, Both are deceived by wiles. This occurs, however, chiefly in the poets. In Livy this is a common construction—especially in the latter member of a sentence having two co-ordinate parts; as, *Jam ne nocte quidem turba ex eo loco dilabebatur, refracturosque carcerem minabantur*. Cicero furnishes scarcely an example, Cæsar and Sallust comparatively few.

SECTION II.—THE GOVERNMENT OF VERBS ONE BY ANOTHER; (*a*) INFINITIVES.

That part of the verb which is not limited in regard to persons and numbers, and the notion of time implied in which is unlimitedly extended to past, present, or future, as contemporaneous with any of them, is called the infinitive mood. It might be called the noun of the verb, having a reference to time, but principally expressing the fact or act of the verb, as "to lie is base," that is, the act of lying. It is accordingly used in Latin like a substantive in all the cases except the vocative.

If one verb is used as the subject of another verb it must be put in the infinitive mood, and it is considered as of the neuter gender; as *Ignoscere amico humanum est*, To forgive a friend is humane.

If one verb is used as the object of another verb it must be put in the infinitive; as *Volo hoc dicere*, I wish to say this; *Agros colere cœperunt*, They began to till fields; *Bonum est erudire et erudiri*, It is a good thing to learn and to be learned.

But verbs of asking, commanding, advising, intending, and affecting govern the subjunctive with *ut* instead of the infinitive; as *Te oro et hortor ut diligens sis*, I beg and exhort you to (to the end that you may) be diligent. *Jubeo* and *veto*, however, require an accusative with an infinitive; as *Græcus Aristippus, servos qui projicere aurum in media jussit Libya*, The Greek Aristippus, who ordered his slaves to fling down his gold in the middle of Libya; *Qui non vetat peccare, quum possit, jubet*, He who, when he can, forbids not sin, commands it.

Sometimes verbs of the infinitive mood occur or are used alone in narrative sentences instead of the present or imperfect indicative. This is called the historical infinitive. Grammarians usually explain it by an ellipsis of *incipiebat, solet, cœpit*, or *cœperunt*, which may often be supplied; in other cases, however, these words will not accord with the sense; as *Multi sequi, fugere, occidi, capi*, Many were following, flying, being slain, being captured; *Postquam in ædes irruperunt, diversi, regem* [*cœperunt*] *quærere; dormientes alios, alios occursantes interficere; scrutari loca abdita; clausa effringere; strepitu et tumultu omnia miscere*, As soon as they rushed into the house, taking different ways, they [began] to ask for the king; to slay some sleeping, some as they met them fleeing; to search into secret places; to break open those which were lockfast, [and] to fill the whole place with shouting and uproar.

The use of an infinitive after an adjective is common in poetry, especially lyric; as *Audax omnia perpeti*, Bold to endure all things; *Fruges consumere nati*, Born to consume the fruits. In the best prose, though Tacitus adopts it freely, the infinitive is used with but few words; such as *Paratus, assuetus*, &c.

A participle sometimes discharges the duty (*i.e.* may occupy the place) of an infinitive; as *Sensit delapsus in medias hostes*, He perceived that he had fallen among the enemy.

The gerund in its nature really very much resembles the infinitive. Hence the one is frequently put for the other; as *Est tempus legendi* (or *legere*). But the gerund is never joined with an adjective, and it is sometimes taken in a passive sense; as *Cum Tisidium vocaretur ad imperandum* (i.e. *ut ipsi imperaretur*), When he was called to Tisidium to receive orders.

Verbs in the infinitive mood are added in a prolative manner (*i.e.* to carry on the construction of a sentence) to certain verbs, participles, and adjectives; and (by the poets) even to substantives; as

Vis doceri,	*You are willing to be taught.*
Hector dicitur cecidisse pro patria,	*Hector is said to have died for his country.*
Erat dignus amari,	*He was worthy to be loved.*
Tempus abire tibi,	(*It is*) *time for you to be gone.*

The verbs used in this construction are the following and those similar—viz. *amor, audeo, cœpi, cogito, cogor, conor, constituo, consuevi, cupio, debet, incipio, nequeo, malo, nolo, obliviscor, paro, possum, queo, scio, soleo, statuo, studeo* (to intend), *tento, volo*, &c.

In prose writers the proper use of *dignus, indignus*—though otherwise in the poets—is with *qui* and a subjunctive; as *Dignus qui* (or *ut*) *amaretur*, Worthy to be loved.

Infinitives are put by poets in the place of gerunds; as *Deceratque comas diffundere ventis*, She had given her hair to be tossed by the winds; *Argenti magnum dat ferre talentum*, He gives a great talent of silver to carry.

Infinitives, gerunds, participles, and the supine in *um*, besides being governed by other words—as explained above—also govern the same cases as the finite verb; as

Cupio satisfacere reipublicæ,	*I desire to satisfy the state.*
Cupidus sum satisfaciendi reipublicæ,	*I am desirous of satisfying the state.*
Ast ego non Graiis servitum matribus ibo,	*But I will not go to be a slave to Greek matrons.*

The present and the perfect of the infinitive correspond respectively not only to the present and perfect, but to the imperfect and pluperfect of the indicative as well; as

Respondeo, placere et mihi locum,	*I answer, that the place pleases me too.*
Respondit, placere et sibi locum,	*He answered, that the place pleased him too.*

In Latin prose the infinitive never expresses a purpose. When, therefore, an English infinitive may be turned into "in order that" or "that," with "may" or "might," it is to be translated into Latin by *ut* with the subjunctive of a verb, but in a negative sentence *ne* takes the place of *ut;* as *Venit ut discat*, He came [that he may] to learn.

In many verbs this relation of purpose is expressed obscurely. Purpose (*i.e.* intention to do anything) is in Latin expressed by (1) *qui* followed by a subjunctive; (2) *ut* followed by a subjunctive; (3) a supine; (4) a future participle; (5) a gerund; (6) a gerundive; or (7) *causa* or *gratia* with a genitive; as

Venit qui opem oraret, Venit ut opem oraret, Venit opem oratum, Venit opem oraturus, Venit ad orandum opem *or* Venit ad orandam opem, Venit opis orandæ causæ *or* Venit opi orandæ, Venit opem orandi causa,	*He came to ask aid.*

The accusative, with the infinitive, follows (1) such verbs as denote to see, hear, know, feel, think, say; (2) such expressions as *æquum est*, it is just; *verisimile est*, it is likely; *certum est*, it is certain; *apertum est*, it is plain; *opus est*, it is needful or necessary; (3) the third person singular of the passive voice.

When "that" comes before two verbs without denoting intention, purpose, or design this construction obtains—viz.

Certum est hominum causa factum esse mundum, quæque in eo sint omnia,	*It is certain that the world and everything in it was made for man.*
Longum est enumerare prœlia Cæsaris,	*It is a long story to detail the battles of Cæsar.*
Stultum est timere quod vitari non potest,	*It is foolish to fear what cannot be avoided.*
Credibile est omnia consilio fieri,	*It is probable that all things happen by design.*
Scio Ciceronem fuisse eloquentum,	*I know that Cicero was eloquent.*
Audiet cives acuisse ferrum,	*He will hear that the citizens have whetted the sword.*
Vidimus flavum Tiberinum ire dejectum monumenta regis,	*We have seen the yellow Tiber* [*to*] *go to overthrow the palace of the king.*
Quid Romæ faciam? Mentiri nescio!	*What should I do at Rome? I know not* [*how*] *to lie!*
Ait Cæsarem scribere,	*He says that Cæsar is writing.*
Nunciat Cæsarem rediisse,	*He announces that Cæsar has returned.*
Cæsarem venturum esse constat,	*It is well known that Cæsar will return.*
Me-ne incepto desistere victam?	*Is it for me, like one vanquished, to desist from my design?*

In using verbs indicative of grief, joy, surprise, admiration, or such as require that the object of the verb, along with some indication of the cause of an emotion, should be expressed, we should use after the former verb the relative *quod* with a finite verb following it, rather than the infinitive; as *Doleo quod stomacharis*, I am grieved that you should be angry; *Gaudeo quod scripsisti*, I am glad that you have written.

(*b*) GERUNDS, SUPINES, AND PARTICIPLES.

Gerunds and supines may be construed as cases of the infinitive [*i.e.* of the verb used as a noun].

(1) *Gerunds*—

Gen.	*-ndi* is joined to	nouns and adjectives.
Dat.	*-ndo* "	some adjectives and verbs.
Acc.	*-ndum* "	prepositions (*ad*, *inter*, *ante*, &c.)
Abl.	*-ndo* "	prepositions (*in*, *de*, *ab*, *ex*, &c.); also verbs and adjectives.

Cupidus sum spectandi,	*I am desirous to see (of seeing).*
Oblector spectando,	*I am amused with seeing.*
Venio ad spectandum,	*I come to see.*
Loquor de spectando,	*I speak about seeing.*

(2) *Supines*—

Acc.	*-um* is joined to	verbs of motion.
Abl.	*-u* "	adjectives and a few verbs.

Lusum it Mæcenas, dormitum ego Virgilusque,	*Mæcenas goes to play, I and Virgil to sleep.*
Digna spectatu,	*Things worthy to be seen.*

The supine in *um* is used with the verb *eo*, I go, when it signifies that one sets himself about doing a thing. And for this reason the supine with *iri*, used impersonally, supplies the place of the future infinitive passive—*e.g. Constat captivos ab hostibus occisum iri*, It is evident that the enemy are going to slay the captives.

It will be found that the supine in *um* is put after other verbs besides verbs of motion; as, *Dedit filiam nuptum*, He gave his daughter in marriage; *Cantatum provocemus*, We pressed upon them to sing; *Revocatus defensum patriam*, He was recalled to defend his native land; *Divisit copias hiematum*, He divided his forces to their winter quarters.

The supines in *u* in use are, *dictu*, *auditu*, *cognitu*, *factu*, *inventu*, *memoratu*, and *natu;* and the adjectives which govern them are, *honestus*, *turpis*, *jucundus*, *facilis*, *incredibilis*, *memorabilis*, *utilis*, *dignus*, and *indignus; grandis*, *major*, *minor*, *maximus*, and *minimus; fas*, *nefas*, *opus;* and others of similar signification—*e.g.*

Miserabile visu,	*Sad to be seen.*
Opus dictu,	*Necessary to be spoken.*
Nefas scriptu,	*Unlawful to be written.*

This supine may be rendered by (1) the infinitive or (2) gerund with the preposition *ad;* as, *Difficile cognitu*, *cognosci*, or *ad cognoscendum; Res facilis ad credendum.* The former is a poetic construction; as, *Mortem spernere nobilis*, It is noble to contemn death.

Gerunds governing the accusative are elegantly turned into participles in *dus*, which, like adjectives, agree with their substantives in gender, number, and case.

E terra ignem elicimus ad colendos agros,	*We extract from the earth fire for agriculture.*
Occasio videbatur rerum novandarum,	*It seemed an opportunity for making a revolution.*
M. Antonius fuit triumvir reipublicæ constituendæ,	*Mark Antony was a triumvir for the settlement of the state.*
Exercenda est memoria ediscendis veterum scriptis,	*The memory may be exercised by the study of ancient writings.*
Brutus in liberanda patria est interfectus,	*Brutus was slain in setting his country free.*

The nouns which most frequently govern the gerund in *di* are such as *amor*, *causa*, *gratia*, *studium*, *tempus*, *occasio*, *ars*, *otium*, *voluntas*, *cupido*, &c. The adjectives are generally verbals.

Adjectives signifying usefulness and fitness are those which govern the gerund in *do;* as, *Charta utilis scribendo*, Paper useful for writing; *Aqua nitrosa utilis est bibendo*, Nitrous water is good for drinking.

The adjective is often understood; as, *Non est solvendo* [i.e. *par* or *aptus*], He is not able to pay.

When governed by a verb this gerund usually indicates purpose or design; as, *Epidicum quærendo operam dabo*, I will do my endeavour to find out Epidicus.

The gerund in *dum* is used after prepositions for the accusative of the infinitive.

Breve tempus satis est longum ad bene vivendum,	*A short time is long enough for living well.*
Mores puerorum se inter ludendum detegunt,	*The characters of boys reveal themselves in playing.*

The nominative gerund with the verb *est* always implies necessity, and if a dative is used after it, it indicates the person on whom the necessity lies.

Vivere discendum est,	*We must learn to live.*
Linguæ moderandum est mihi,	*I must govern my tongue.*
Efficiendum est, ut appetitus obediant rationi,	*We must manage that appetite shall obey reason.*
Utendum est exercitationibus modicis,	*Moderate exercise should be used.*
Abeundum est tibi.	*You must needs go.*

The gerund in *do* of the ablative case is governed by prepositions, expressed or understood; as

Pars honesti versatur in tribuendo suum cuique,	*One branch of morality lies in giving each his own.*
Parva non contemnendo majores nostri maximam hanc rem fecerunt,	*By not despising small things our ancestors made this commonwealth very great.*

Latin expressions involving the use of infinitives, gerunds, and supines may be varied by different constructions; *e.g.* the English sentence "They come to see the games" may be reproduced in Latin by *Veniunt* (1) *spectatum ludos*, (2) *spectandi ludos causa* or *gratia*, (3) *spectandorum ludorum causa*, (4) *spectandi ludorum causa*, (5) *ad spectandum ludos*, (6) *ad spectandos ludos*, (7) *ludis spectandis*, (8) *ludos spectaturi*, (9) *ut* or *qui ludos spectent*, and (10) *ludos spectare* (poetically), and so in similar cases.

The gerund is not followed by the genitive of another noun; as, *Ad fruendum frugibus terræ*, For the enjoying of the fruits of the earth.

The participle is in one mode of its use an adjective, and, like the adjective, it agrees with its substantive in gender, number, and case; as, *Puerum ludentum vidi*, I saw the boy playing; but in another mode it is a verb, and expresses time. Hence it is in their verbal use that participles, gerunds, and supines [except that in *u*] govern the same case as the verbs of which they are parts; as, *Tendens ad sidera palmas*, Outspreading his hands towards heaven; *Usus scribendi epistolas*, The practice of writing letters; *Rogatum auxilium*, To ask aid. The same is also the case with verbals in *bundus;* as, *Vitabundus hostium castra; Velut gratulabundus patriæ expiravit.*

Participles taking the genitive are adjectival, and denote the *disposition* or *faculty* without reference to time; as, *Patiens laboris*, Capable of enduring labour. But exercising their usual government they are verbal; as, *Patiens laborem*, Actually enduring labour [at any given period].

In the active voice there are two participles—(1) One representing an action or condition *in progress*, and accordingly, if *present* actions are spoken of, it may be regarded as a present participle; as, *Accusat me dicens me ad hostes transfugisse*, He accuses me, saying [*i.e.* at present] that I deserted to the enemy. If *past* actions are spoken of, it may be termed the participle of the imperfect; as, *Accusavit me dicens* [*i.e.* meanwhile] *me ad hostes transfugisse*, He accused me, saying that I had deserted to the enemy. The *future* participle represents an action or condition as intended, or as to take place, in future time; as, *Milites adversus urbem profecturi per totam noctem in castris se tenebant*, The soldiers intending to march against the city kept themselves all night within the camp. The active voice has no participle for a *completed* action. The passive voice, if we except the gerundive, has only one participle, which expresses a completed action; as, *Injuria illata*, An injury [having been done, *i.e.*] which has been done.

What is called the perfect participle passive is often equivalent to a substantive; as, *Ab urbe condita*, From the foundation of the city [*i.e.* from the city being founded]; *Post Athenas captas*, After the capture of Athens.

A substantive, when its case depends upon no other word in a sentence, may be combined with a participle in the ablative, which is then called *absolute;* as, *Regibus exactis, consules creati sunt*, Kings having been driven out, consuls were elected. If the substantive to which a participle is joined is either the nominative to a verb, or is governed by any other word, it is not independent, and therefore no need occurs for such a form of phrase.

The ablative absolute being really an abridged clause, the participle may often, in writing Latin, be transformed into a finite verb with conjunction; as, *Regibus exactis* may equally well be expressed by *postquam reges exacti sunt*, *Superbo regnante* by *cum* [*dum* or *quando*] *superbus regnabat*, and *Opere peracto* by *post opus peractum* or *cum opus est peractum*, &c.

The perfect participles of deponent verbs are not used in the ablative absolute; as, *Cicero locutus hæc consedit*, never *his locutis*.

The participle *existente* or *existentibus* may very frequently be regarded as understood; as, *Cæsare* [*existente*] *duce*, Cæsar being general [or under the conduct of Cæsar]; *His* [*existentibus*] *consulibus*, In their consulship; *Saturno rege* or *saturno regnante*, In the reign of Saturn.

The principal clauses in which the ablative absolute is employed indicate—

(1) Time; as, *Imperante Augusto*, When Augustus was Emperor; *Dubitantibus ceteris*, Whilst the rest were hesitating.

(2) Cause; as, *Hieme nondum confecta*, As the winter was not yet over.

(3) Condition; as, *Hoc facto tutus eris*, If you do this you will be safe.

(4) Concession; as, *Hoc facto, damnatus est*, Though he did this, he was condemned.

LESSON IN READING.

ARIADNE IN NAXOS.

FROM OVID, WITH INTRODUCTION AND ANNOTATIONS.

Ariadne, daughter of Minos, King of Crete, furnished Theseus, when he undertook to slay the Minotaur, with a clue of thread, so that he might be able to return from the den of that monster which claimed an impost of seven youths and seven maidens annually from Crete. Theseus succeeded in his task, escaped from the labyrinth, delivered his companions, and carried off the Cretan princess, who was deeply in love with him. Having landed on "Dia's sea-girt isle," Pallas commanded Theseus to abandon Ariadne and hasten to Athens. He does so, and she on awaking finds herself forsaken, starts up, wanders about, exclaims against the cruelty of faithless Theseus, laments his treachery, and is suddenly deafened by cymbals and tabors. The Satyrs, the Bacchantes, and Silenus, in a noisy rout, precede Bacchus, who, smitten with Ariadne's beauty, assuages her fears, promises wedlock, bestows on her a golden crown, which the gods place in the sky as a constellation, where it serves to guide the mariner over the pathless seas. Jove gave fair Ariadne "life everlasting and eternal youth." This romantic tale is one of the most beautiful of the graceful fictions of the Greek mythology. "Ariadne, passioning for Theseus' perjury and unjust flight," has been the theme, not only of Ovid, but of Virgil, Catullus, and Propertius. She is mentioned by Homer and Hesiod, and in ancient sculpture and painting this incident was a favourite subject.

Gnosis in ignotis amens errabat arenis,
  Qua brevis æquoreis Dia feritur aquis.
Utque erat a somno tunica velata recincta,
  Nuda pedem, croceas irreligata comas;
Thesea crudelem surdas clamabat ad undas,
  Indigno teneras imbre rigante genas.
Clamabat, flebatque simul; sed utrumque decebat:
  Nec facta est lacrimis turpior illa suis.
Jamque iterum tundens mollissima pectora palmis,
  Perfidus ille abiit: quid mihi fiet? ait.
Quid mihi fiet? ait. Sonuerunt cymbala toto
  Littore, et attonita tympana pulsa manu.
Excidit illa metu, rupitque novissima verba:
  Nullus in exanimi corpore sanguis erat.
Ecce! Mimallonides sparsis in terga capillis!
  Ecce! leves Satyri, prævia turba Dei;
Ebrius ecce! senex pando Silenus asello
  Vix sedet; et pressas continet arte jubas.
Dum sequitur Bacchas, Bacchæ fugiuntque petuntque,
  Quadrupedem ferula dum malus urget eques;
In caput aurito cecidit delapsus asello.
  Clamarunt Satyri, Surge age, surge, pater.
Jam Deus e curru, quem summum texerat uvis,
  Tigribus adjunctis aurea lora dabat.
Et color, et Theseus, et vox abiere puellæ;
  Terque fugam petiit; terque retenta metu.
Horruit, ut steriles, agitat quas ventus, aristæ;
  Ut levis in madida canna palude tremit.
Cui Deus, En! adsum tibi cura fidelior, inquit;
  Pone metum; Bacchi, Gnosias, uxor eris.
Munus habe cœlum; cœlo spectabile sidus
  Sæpe reges dubiam Cressa Corona ratem.
Dixit; et e curru, ne tigres illa timeret,
  Desilit; imposito cessit arena pedi.
Implicitamque sinu, neque enim pugnare valebat,
  Abstulit; ut facile est omnia posse Deo.

Line 1. *Gnosias*, *Gnosis*, *Cressa*, are each used as names for Ariadne. 2. *Dia* is a small island off the coast of Crete, though it was also one of the names of Naxos, the largest of the Cyclades. *Brevis* indicates that the former is meant. 3. *Recincta*, ungirt. 4. *Croceas*, light-golden, suggestive of both fragrance and colour. 5. *Thesea*, the accus., agreeing with *crudelem*, *esse* understood. 6. *Indigno* is here used in a passive sense. 12. *Attonita*, thunderstruck, and hence frenzied. 13. *Excidit* may have *mente* understood, and *metu* would then be an ablative of instrument. *Rupit* =her voice failed. 14. *Mimallonides*=female votaries of Bacchus. It is of uncertain derivation and signification. 16. *Satyrus* is probably a dialectic form of Tityrus; Doric, a he-goat. 16. *Prævia*, preceding, leading the way. 17. *Silenus* is a sort of antique guardian and tutor of Bacchus. A bald, fat, squat, snub-nosed, pretty often tipsy, old man, yet both a poet and a philosopher.

Prose Translation of the foregoing Text.

The Gnossian [damsel] was wandering distracted[ly] on the unknown sands, Where little Dia is lapped by the sea-wave waters, And just as she was [on starting] out of sleep, wrapped in a loose garment, With bare feet and her saffron-locks dishevelled, She was crying out to the deaf [*i.e.* unheeding] waves that Theseus was cruel, While unmeritedly a shower [of tears] bedewed her tender cheeks. She cried out and wept at the same time—but either became her. She was not made unlovely by her tears. And now, again, beating her soft breasts with her hands, she says, "He faithless has gone! What will become of me?" "What will become of me," she says: Cymbals resounded along the whole shore and tabors were stricken with frantic hand. She fainted with fear and broke off her latest accents. There was no blood in her lifeless frame. Behold the Mimallonides with their hair hanging loose down their backs. Behold the lithe-limbed Satyrs—the crowd preceding the god. Behold the drunken old Silenus on an ass bending [under his weight]. With difficulty he sits [on it] and holds fast by the clasped mane before him. While he follows the bacchanalians, the bacchanalians both fly from and return to him, While the unskilled rider goads the quadruped with a stick. Having slipped from the long-eared ass, he falls off over its head. The Satyrs exclaim, "Come, get up, get up, father." Now the god in his chariot, which he had interlaced with grapes overhead, Slackened the golden reins to the yoked tigers. Both colour and Theseus and voice forsook the damsel. And thrice she sought flight, and thrice was she hindered by fear. She shudders, just like the withered corn-ears, which the wind shakes; just as the slender reed trembles in the moist marsh. To whom the god says, Lo, I am to thee a lover more faithful! banish [your] fear, Gnossian [damsel] thou shalt be the wife of Bacchus. Possess heaven as a gift, thou

shalt be seen a constellation in the sky; Often the Cretan diadem shall guide the veering bark. He spoke, and from the chariot, lest she might fear the tigers, down leapt he. The sand yielded to the planted foot. He bore her off enfolded in his bosom; for she was not strong [enough] to struggle. So to be able to do all things is easy for a god.

PHYSIOLOGY.—CHAPTER XIV.

THE CARE OF PERSONAL HEALTH—HEALTH AND ITS CONDITIONS—AIR—FOOD—DRINK—EXERCISE—CLOTHING—CLEANLINESS—SLEEP.

In the foregoing chapters we have endeavoured to make the main truths of physiology plain and familiar to unprofessional readers, not with the aim of making "every man his own physician," but with the design of enabling them, in some measure, to attend to those teachings of the science of human nature by heed to which they may frequently prevent what might be difficult, if not impossible, to cure. By acquiring some knowledge of the principles and laws on which the health and usefulness of the bodily frame may be maintained, a thoughtful person can avoid the exposure of his system to the causes of disease, the results of which it may be difficult to counteract or eradicate, even by the help of medical skill, the most careful administration of drugs, or the regulation of diet, exercise, &c. We have regarded the details given concerning the structure and functions of the human body not merely as forming a most interesting study in themselves as a branch of science, but as possessing the highest possible claims on the regard of man as necessary aids to the rational care of health—one's own as well as that of others; and we have striven, with plainness and perspicuity, to present such a synopsis of the physical constitution of the body and its relations—at once to the outward agencies to which it is related, and to the inward operations which it is designed to undergo, as well as the work it is specially fitted to accomplish—as may assist the intelligent reader to make his corporeal frame as efficient an instrument as possible in the performance of all requisite duty.

No generally accepted definition of life or vitality has been arrived at by physiologists. "The special activity of organized bodies," by Duges, or "Organization in action," by Béclard, are perhaps the best, just because one may read into them as much or as little meaning as he chooses. If we accept the statement, made on high medical authority, that "a man does not die of this or that ailment, he dies of his own weakness and inability to resist disease," then perhaps Bichat's saying, that "life is the sum-total of the functions which resist death," might be good enough as a working definition. But though we cannot formulate any succinct defining phrase explanatory of life itself, we can form a distinct conception of a living being as a nicely organized unity of different constituents, fitted as a whole, as well as in its particular parts, within certain limits (capable of more or less accurate average specification), of varying in and with immediate circumstances. *Vital functions* are, then, understood to be the visible embodiment of these organic arrangements and constituents in an individual form, operating through all the parts, affecting all the details, and regulating all the results of that organized form—a form which is at once a machine of varying complexity, the architect of its own specific framework, and the superintending agent of its own well-being, not as an inherently independent whole, but very distinctly dependent for its continuance on the mutual exchanges which take place between it and the outward world. This continuance of individuality constitutes life, and the power by which it subsists is called vitality.

When that successive series of definitively arranged changes of structure and composition which constitute the real phenomena of life, takes place within an individual organization once produced—without destroying its identity or lessening its capacity for carrying on its functions in a normal manner—and proceeds, in due course, (1) through growth, (2) the self-balancing co-ordinations of maturity, and (3) the gradual failure of decay, life is said to be healthy. The boundary at which health terminates and disease begins has not yet been settled, and seems to be as difficult to define as life. We can form rather an ideal than an idea of it. Health, in its ideal, is that state in which an originally strong and vigorous organization is (1) equally and thoroughly developed and exercised, (2) capable of performing all the natural functions in a normal manner, and (3) fitted to use every power in the best way for the accomplishment of every duty and requirement. In general usage, however, the word health is employed rather in the negative sense of not being actually incommoded in feeling or inconvenienced in exertion by any disease. Indeed, absolute bodily health is, as a general rule, an unknown (or at least rarely known) condition of human life. Civilization generates diseases peculiar to itself, and savage life is found to be at once precarious and short. In neither state is it given, as yet, to enjoy that full, free, harmonious co-activity of part and function, without inconvenience or pain, for the ordinary possible period of existence, in that unperturbed serenity of experience and exertion which ought to constitute the physiological limit of human life. What may be called the average statistical vitality of man is a great deal lower than the possible vitality of individuals, and it is fair to assume that a vitality which falls far short of the possible longevity attainable by the highest class of lives is exposed to influences inimical to health and tending to disease. If, by an acquaintance with biological facts and attention to the requirements of physiology, such preventible causes or conditions, habits or incidents, as lessen the health-rate and heighten the death-rate, can be diminished in number, power, influence, or incidence, it is advisable that such knowledge should be diffused and used. We propose to gather here, in summary, some of those laws of hygiene to which, on physiological grounds, men must attend who wish to pass, in a pleasant and profitable way, a fairly extended period of existence, that is, to bring into one view a statement of the means of "rendering growth more perfect, life more vigorous, decay less rapid, and death more remote."

The human organization is an economy of various compound processes, whose primary functions are the reception and assimilation of the material elements of external nature, and their transformation into personal happiness and social usefulness. Considered as such the biological requirements of the animal economy are (1) the introduction into the organic system of all suitable and appropriate nutrient materials, as air, food, drink, &c., and the application to it of those external influences which are necessary that it may fitly perform each of its functions, as light, heat, probably electricity, and perhaps other efficacious meteorological agencies, as pressure, moisture, temperature, &c. This, again, might be regarded as involving the converse, *i.e.* the exclusion from the body of all unsuitable materials, and non-exposure to any (avoidable) injurious influences. (2) The due transformation of all nutrient matters into blood and the other normal secretions of the body, and the wholesome operation of all the processes involved in the changes they undergo. (3) The assimilative and reparative appropriation of the nutritional fluids for the structural upbuilding of the frame. (4) The employment of the force generated by this transformation of matter into tissue, in work, exercise, thought, and happiness. (5) The removal of effete tissue and unused material from the body, that the machinery may work unclogged and the functions be left free from interference with their regular course. Stated in these general terms the problem of hygiene seems calculated to do little more than afford some conception of the end in view in laying down some plain abstract of the laws of health and of the means best fitted to secure it. Something more must, however, be attempted in order that our remarks may be intelligible, exact, and practically useful. But it must be remembered that statements which the necessities of exposition compel us to make in succession, and to mark off as distinct from one another by the most definite descriptive words one's mind can furnish on demand, require to be kept in simultaneous view in thought and practice, and to be observed in their entire completeness throughout a whole life's experiences. The

functions of organic life maintain among them a close correlation and interdependence. Thus fresh supplies of alimentary substances are necessary to the continuous replenishment of the circulating fluid. Without this constantly flowing river of life there would be no secretion, without secretion no digestion, without digestion no nutrition, without nutrition no aptitude for food and no need of it. So long as life lasts this circle of change, of motion, and mutation go on in recurring rotation, and when these interchanges and transformations terminate, life is at an end. The organic processes, according to the laws which regulate life, must be carried on in unintermitting evolution and revolution if health is to be maintained. It is of great importance for our own comfort and the comfort of others, that we should try to keep ourselves in good health, so far as we are able. To do this—and so to be fitted to fulfil duty, enjoy existence, and impart enjoyment—we must bring our lives into conformity with the facts and conditions of our existence.

Air.—As regards air we must secure such an amount as shall enable us to perform, in a proper manner, the full process of respiration, and therefore must endeavour to keep our bodies in a fit state to receive and use a proper quantity of pure air, that is, air uncontaminated by organic or inorganic substances held in suspension in it, insalubrious gases, and animal or other effluvias or impurities. This air must be sufficiently diffused and oxidized by securing thorough ventilation, and it should be, as far as possible, maintained at a suitable and uniform temperature according to the season of the year. See Chap. ix., pp. 705–709.

Food.—This, considered in its broadest sense, includes all the materials requisite for the upbuilding and maintenance of the body. It must be such in quality and quantity as shall keep up the chemical balance of the physical frame, and preserve all its constituent parts in orderly well-being. This implies that, in order to provide each tissue with the means of securing a fair supply of the elements necessary for its nourishment, our food should be well-chosen and varied; wholesome and properly cooked, as all organic structures used for that purpose (except ripe fruits and oysters) should be; and rightly adapted to the condition of the body and the general habits of the individual, as growing, mature, or lapsing into the autumn of his days. In taking food we should be careful to establish regular habits, and to attend to them when formed. The following cautions and precautions should be observed:—(1) The stomach ought to be moderately filled, but never distended. (2) The time allowed to elapse between meals should be such, on the average, as to permit food first taken to have completely left the stomach before the next supply is introduced. (3) Gentle exercise or ordinary work is beneficial before a meal, exacting work or over-exertion is injurious after one. (4) Good-humoured tranquillity of mind is essential to speedy and effective digestion. Hence the propriety of endeavouring, by kindly talk and social suavities, to keep the feelings calm and the temper unruffled. (5) The state of health in which one is should exercise a regulative influence on the diet taken. A strong healthy man can digest what would excite intolerable dyspepsia in a person of weaker powers; and food which in one condition of body would be relished and acceptably applied to the nourishment of the frame, will trouble, pain, and perhaps injure in another. "Therein the patient must minister unto himself" by prudence, care, and good sense. (6) The state of the weather often enters as a condition of taking food appropriate to the season. Often one feels the dull pressure of a heavy atmosphere affecting the digestive operations, and the stirring power of sunshine and serenity is equally apparent. (7) Food ought to be adapted to the special nature of the frame, the obese feeding differently from the lean, and *vice versâ*, and the food of the young should be different from that of the old. The entire result of the study of nutrition leads to these practical principles: (1) that highly carbonized food, with a moderate amount of nitrogenous matter in it, is, as a general rule, best fitted for the maintenance and growth of the bodily tissues; (2) that the value of a food does not depend on its possession of any one constituent, but of the fitness of the total admixture of it for being readily received into and assimilated with the organism, and of course the ability of the frame so to receive and assimilate what is eaten. Hence (3) as food requires to fulfil various duties in the body, it should be varied; and as the general average of use is regulative of the general average of supply required, so (4) our habits in regard to meals should be regular, and our dietary arranged to suit the average condition of our constitution. Drinks are really liquid foods. A juicy fruit at once assuages thirst and allays hunger. Water and all the fluids contain more or less of solid matter, and even solid food, like uncooked beef, contains from 70 to 80 per cent. of water. Fresh onions present only 6 per cent. of solid matter, and a cucumber somewhat about 3 per cent. In reality, therefore, the two forms of sustenance cannot be accurately distinguished.

Drinks, however, are taken to dilute food and assist in the solution and conveyance of solid food. Thirst is really the sign that the blood requires either (1) dilution owing to excitement or stimulation, (2) a supply of the means of replacing what it loses by perspiration through exercise, external heat, or the use of too highly seasoned food, or a recruitment for the too lavish expenditure of the fluids of the frame by depressing conditions or diseases. Drink is necessary to secure the due diffusibility of the nutrient materials the blood carries in it. An averagely healthy adult's blood contains about 77 per cent. of water, and when this average is lessened, the clamminess of the mouth and throat, and the disturbed condition of the digestive apparatus, indicate that the balance should be restored. Thirst is a symptom in many diseases, but natural thirst is merely a sign that the working fluid of the system requires replenishment. This is best done in ordinary cases by pure water, or water and milk, or by cold (unsweetened) tea. Unnecessary drink only gives the body the burden of removing it, and, when of a heating nature, increases rather than alleviates the febrile symptoms of a self-created thirst. Mucilaginous, farinaceous, and saccharine drinks, as barley-water, gruel, toast and water, are slightly nutritive and quench thirst mildly. Acidulated drinks, as lemonade, ginger beer, &c., are mostly useful therapeutically [*i.e.* curatively or remedially] in softening the textures of animal food, and in fitting the albuminated contents of the intestines for diffusion through the lacteal and capillary ducts. Aromatic or astringent drinks, as tea, coffee, chocolate, cocoa, &c., have not yet received from chemistry a clear explanation of their relations to food and their power over tissue. At present, the prevailing opinion is that such infused beverages, though they make absorption more rapid, cause a loss of nutritious substance, that the digestion of albuminous food-stuffs is in most cases retarded, and that starchy and glutinous foods are, apparently, most assisted by their use. Drinks of a gelatinous nature, as soups, broths, &c., if properly prepared, are readily assimilated and easily distributed. Milky drinks, if animal, are highly, if vegetable, but slightly nutritive. Alcoholic drinks are seldom necessary, often injurious, and always dangerous. The most perfect health is possible without them, and as articles of diet they should, in general, be taken only under medical sanction and in prescribed quantities. The importance of healthy drinks may be approximately realized by those who remember that of an average human body, weighing 154 lbs., 111 lbs. are water.

Exercise.—In the natural order of things exercise, in the shape of work, is the lot of the many. But almost all work is continuous and often monotonous and routine, engaging largely some parts of the body and leaving others unused. Exercise is that supplement to work which brings into play the parts unused or only slightly so, and is so arranged as to increase the healthy action of the lungs and heart, and to secure the speedy replacement of old and worn-out matter by fresh and new vital products. But all vital products when used and transformed, if allowed to accumulate within the system become dangerous to health and must be got rid of. Ptomanies (Gr. *ptoma*, a carcase) [*i.e.* digested and used-up cadaveric matter, the residue of the vital processes], if retained in the body instead of being destroyed, replaced, and thrown off or cast out, are found to be pernicious, evolve into disease, and pervade the organization. Hence the vital value of due

and well-proportioned exercise as an important element in personal regimen educatively, as gymnastics, drill, &c.; habitually, as walking, riding, games, amusements, sports, &c., of various sorts—of which those practicable in the open air and in social (but not over-exciting) surroundings are the best. Overstrain and overtaxing must in all cases be carefully avoided. Rest must intermit labour, and exertion should be equated to power and health. Sudden fits of violent exercise after lengthy periods of sedentariness are generally injurious and *vice versâ*.

Clothing ought to be of such a sort in texture and quantity as shall (1) keep the temperature of the body as uniform as possible, (2) interfere as little as may be with the functions and development of the frame, and (3) give the utmost facilities for the operation of fresh air on the surface, and the dispersion or abstersion of perspiration or exudation. Hence garments should be appropriate to the season of the year, the climate's difference, the nature of the weather, and the various vicissitudes which by their occurrence expose the person to sudden alternations of heat and cold. Wearing of warm clothing in winter enables us to do with less artificial heat and less heat-forming food. The clothing next the body ought to be absorptive of animal moisture and retentive of normal heat. Uniformity of temperature is a cheap medicine.

Cleanliness is essential to the proper action of the skin, the ready exchange of effete material, and the adequate arterialization of the blood. In normal health the body should be washed all over in cold water, which may be used tepid in various degrees by persons of weaker capacity.

Sleep should be taken at regular seasons—preferentially between nightfall and sunrise—with certain limitations and no license in good health to temporary inclinations. Sleeping apartments ought to be cool, well-ventilated, and free from draughts. Hair is superior for health purposes to feathers. The bedclothes ought to be loose and comfortably heavy without being weighty. A brief cessation from active labour or mental activity should intervene before retiring to a night's rest. The body should be cool, comfortable, and unburdened by newly taken food or voidable matter, and the mind calm, settled, and free from harassment of business, worry of temper, excitement from novel-reading or amusement, or from the reflection that the duties of the day have been neglected or left undone.

BOOK-KEEPING.—CHAPTER XIII.

THE LEDGER.

We have now reached the most important of the books in any mercantile concern—the Ledger. In it every transaction appears in its final form, classified under, and distributed among, specific headings or accounts, each of which indicates what sort of entries have a place in it; each of which too, must, unless the amounts on the opposite sides exactly tally [*i.e.* balance], show a difference either (1) in favour of the business as an "asset," or (2) against it as a "liability." Hence particular care requires to be taken in the posting of the Ledger.

Posting the Ledger signifies the transferring of the different items of the Journal, or such other book as is used in lieu of it, into the Ledger.

Each entry in the Journal requires to be posted twice in the Ledger—viz. (1) once on the *right* hand side of some special account, and (2) once on the *left* hand of some other account.

There are *six* arbitrary accounts in the Ledger of great general importance, which are all kept in close relation to each other—viz. Cash, Stock, Goods, Bills Receivable, Bills Payable, and Profit and Loss. These will be seen worked out in the examples, and should be carefully noted.

All the personal accounts which are given in the single entry form on pp. 1002–1004 will present in the double entry form precisely the same items, entries, and balances, and will differ only in having, instead of double money columns into which the sums accruing respectively to Dr. and Cr. are placed, two opposite forms for the entries, so that the Dr. occupies the left-hand side of the folio and the Cr. the right, and constitute distinct and separate sides of the Ledger. We need only therefore exhibit a single example in the double entry form. This will be found under the heading "John Reid, Edinburgh." The student is requested to work out all the others in the same manner, placing all the entries in the Dr. columns on the one side of the folio he uses, and those in the Cr. columns on the other side, and making sure that he not only gets the same results, but also understands why these results come to be what they are. Taking it for granted that these will all be done—although for space' sake not repeated here—we exhibit the real accounts, *i.e.* accounts regarding the goods in which the person trades whose books are being kept.

LEDGER INDEX.

Note.—The *figures* here given are merely exemplary, not referential.

LEDGER.

Dr. **WILLIAM KING, CAPITAL ACCOUNT.** Cr.

Date.			Fol.	Amount. £	s.	d.	Date.			Fol.	Amount. £	s.	d.
1898.							1898.						
Jan.	25	To Cash, ...	1	10	0	0	Jan.	1	By Cash, ...	1	1500	0	0
Feb.	20	" Cash, ...	2	10	0	0	Feb.	28	" Profit and Loss Account, . .	3	117	15	$11\frac{3}{4}$
"	28	" Balance Account, . . .	3	1597	15	$11\frac{3}{4}$							
				1617	15	$11\frac{3}{4}$					1617	15	$11\frac{3}{4}$

CASH ACCOUNT.

Date.			Fol.	Amount. £	s.	d.	Date.			Fol.	Amount. £	s.	d.
Jan.	31	To Cash, ...	1	2273	8	$8\frac{1}{2}$	Jan.	31	By Cash, ...	1	2173	12	$4\frac{1}{2}$
Feb.	28	" Cash, ...	2	1220	5	$10\frac{1}{2}$	Feb.	28	" Cash, ...	2	994	18	$3\frac{1}{2}$
							"	"	" Balance Account, ...	3	325	3	11
				3493	14	7					3493	14	7

NATIONAL BANK ACCOUNT

Dr. | Cr.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
1898. Jan.	31	To Cash,	1	1409	10	0	1898. Jan.	31	By Cash,	1	235	0	0
Feb.	28	" Cash,	2	215	0	0	Feb.	28	" Cash,	2	144	0	0
									" Balance Account,	3	1245	10	0
				1624	10	0					1624	10	0

GOODS ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Jan.	31	To Credit Purchases,	1	203	17	6	Jan.	31	By Credit Sales,	1–2	56	14	7
Feb.	28	" "	2	68	0	6	Feb.	28	" "	2–3	54	15	0
Jan.	1	" Cash Purchases (Stock 1),	1	350	0	0	Jan.	31	" Cash Sales,	1	146	9	6
"	31	" "	1	42	10	0	Feb.	28	" "	2	100	19	11
Feb.	28	" "	2	67	10	8	"	"	" Sundry Accounts,	1	636	18	11¾
"	"	" Plumber Goods Account,	1	88	0	0							
"	"	" Profit and Loss Account,	2	175	19	3¾							
				995	17	11¾					995	17	11¾

TRADE EXPENSES ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Jan.	31	To Cash,	1	10	8	2	Feb.	28	By Profit and Loss Account,	2	38	4	1
Feb.	28	" Cash,	2	27	15	11							
				38	4	1					38	4	1

COMMISSION ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Feb.	28	To Profit and Loss Account,	2	37	4	0	Feb.	28	By Sundry Accounts,	2	37	4	0

BAD DEBTS ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Feb.	28	To Sundry Accounts,	2	27	15	5	Feb.	28	By Profit and Loss Account,	2	27	15	5

PLUMBER GOODS ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Jan.	5	To Robert Wilson,	1	134	6	6	Jan.	4	By John Reid,	1	25	2	9
"	18	" Theodore Horne,	1	22	10	6	Feb.	21	" Peter Stevenson,	3	28	8	4
Feb.	15	" Robert Wilson,	2	37	5	0	"	28	" Stock Account,	1	52	10	11
							"	"	" Goods Account,	1	88	0	0
				194	2	0					194	2	0

IRONMONGERY ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Jan.	23	To John Henderson,	1	9	11	3¼	Jan.	4	By Charles Smith,	1	31	5	10
Feb.	11	" James Jobson,	2	34	15	0	"	18	" James Jackson,	1	9	7	0
"	28	" Goods Account,	1	33	9	2¾	"	22	" Peter Stevenson,	2	8	12	10½
							"	"	" John Brown, Greenock,	2	8	14	2
							Feb.	8	" John Coutts, Glasgow,	2	7	13	4½
							"	28	" Stock Account,	1	12	2	3
				77	15	6					77	15	6

GROCERIES ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Jan.	26	To Peter Paterson,	1	110	4	1	Jan.	18	By Samuel Johnston,	1	268	3	6
Feb.	6	" James Grierson,	2	95	15	2½	Feb.	2	" John Kerr,	2	58	4	5
"	28	" Goods Account,	1	248	8	9	"	16	" John Brown,	2	39	15	2
							"	18	" Samuel Johnston,	2	53	7	5
							"	27	" John Brown,	3	30	8	1½
							"	28	" Stock Account,	1	4	9	5
				454	8	0½					454	8	0½

DISCOUNT ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Jan.	31	To Cash,	1	19	8	7½	Jan.	31	By Cash,	1	5	0	7
Feb.	28	"	2	0	2	9	Feb.	28	" "	2	0	17	8½
							"	"	" Profit and Loss Account,	2	13	13	1
				19	11	4½					19	11	4½

WHISKY ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Feb.	28	To Goods Account,	1	355	1	0	Jan.	30	By Roderick Dhu,	2	355	1	0

MANURE ACCOUNT.

Date			Fol.	£	s.	d.	Date			Fol.	£	s.	d.
Jan.	14	To James Innes,	1	18	16	8	Feb.	28	By Stock Account,	1	46	9	8
Feb.	28	" "	2	27	13	0							
				46	9	8					46	9	8

CLOTH ACCOUNT.

Date.			Fol.	Amount. £	s.	d.	Date.			Fol.	Amount. £	s.	d.
1898. Jan.	31	To John Robertson,	1	312	10	0	1898. Feb.	28	By Stock Account,	1	312	10	0

BILLS RECEIVABLE ACCOUNT.

Jan.	31	To Bills,	1	300	0	0	Jan.	31	By Cash—Roderick Dhu's Bill,	1	300	0	0

BILLS PAYABLE ACCOUNT.

Feb.	26	To Cash,	2	100	0	0	Jan.	31	By Bills Granted,	1	116	12	6
"	28	" Balance Account,	3	16	12	6							
				116	12	6					116	12	6

STOCK ACCOUNT.

Feb.	28	To Sundry Accounts,	1	428	2	3	Feb.	28	By Profit and Loss Account,	2	15	14	9
							"	"	" Balance Account,	3	412	7	6
				428	2	3					428	2	3

OUTSTANDING DEBTS ACCOUNT.

Feb.	28	To Sundry Accounts,	2	126	7	$11\frac{3}{4}$	Feb.	28	By Sundry Accounts,	2	495	0	11
"	"	" Balance Account,	3	368	12	$11\frac{1}{4}$							
				495	0	11					495	0	11

PROFIT AND LOSS ACCOUNT.

Feb.	28	To Sundry Accounts,	2	95	7	4	Feb.	28	By Sundry Accounts,	2	213	3	$3\frac{3}{4}$
"	"	" Wm. King, Capital Account,	3	117	15	$11\frac{3}{4}$							
				213	3	$3\frac{3}{4}$					213	3	$3\frac{3}{4}$

BALANCE ACCOUNT.

Feb.	28	To Sundry Accounts,	3	1983	1	5	Feb.	28	By Sundry Accounts,	3	1983	1	5

JOHN REID, EDINBURGH.

Dr.											Cr.		
Jan.	4	To Plumber Goods Account,	1	25	2	9	Feb.	12	By Cash,	2	25	2	9
Feb.	24	" Goods,	3	12	10	4	"	28	" Outstanding Debts Account,	2	12	10	4
				37	13	1					37	13	1

GEOMETRY.—CHAPTER XIII.

THE PROPERTIES AND RELATIONS OF RECTANGLES.

Euclid's Second Book proceeds to develop the Pythagorean theorem, which constituted the culminating point of the geometry of the First Book, and to direct us in the mathematical investigation of the relations subsisting between the squares and rectangles which can be described upon the parts into which any given straight line may be divided. All the propositions of this book relate to the areas of these squares and rectangles, and the aim of Euclid is to enable us, by the comparison of two lines to compare two areas. The student will remember that in Book I. 42–45, he was taught how a rectangle may be constructed equal in area to any given figure bounded by straight lines; but he is now to be shown that the square described [or supposed to be described] on any bounding straight line is equal in area to some given rectilinear figure, and *vice versâ*. There are, in fact (as Euclid I. 35 demonstrates), an indefinite number of parallelograms on the same [subsequently extended also to similar] bases, between the same parallels, which have their areas equal to one another. The area of any such rectangular parallelogram is therefore really determined by the two lines which contain one of its right angles. It must be remembered that a rectangle is *bounded* by four straight lines, though we have this given us as

Definition 1.—"Every right-angled parallelogram is called a rectangle, and each rectangle is said to be *contained by* any two of the straight lines which contain one of its right angles." In the text of Euclid, however, the student will find rectangles spoken of as contained by two straight lines, meaning rectangles which have two adjacent sides of the one equal to the two similar straight lines in the other.

All lines are measured by lines, and all surfaces by surfaces. When some line of definite length has been fixed upon, however arbitrarily assumed as the unit of linear measurement, the length of every other line may be represented by the number of linear units it contains. The unit assumed for the measurement of surfaces is the square. This square unit (or unit of area) is that square the side of which is one unit in length, and the *magnitude* of any surface is expressed (or represented) by the *number* of square units contained in it. This connection or relation between number and magnitude in regard to the representation of lines and areas requires to be clearly appreciated by the mind. In a general way a geometrical *rectangle* corresponds to an arithmetical or algebraic *product*, and hence the geometrical properties of rectangles may be made the subject of arithmetical or algebraic proof. This holds good perceptibly for all rectangles of commensurable sides [*i.e.* sides having a common measure], but it does not hold equally good for incommensurable ones. Such a method of computation implies (1) that all magnitudes are either (*a*) multiples or fractions, or (*b*) compounds of multiples and fractions of some (expressible) unit; and (2) that of any two commensurable quantities, the magnitudes must be to one another in the proportion of some whole number to some other whole number. There are, however, incommensurable magnitudes. Of this Euclid [X. 117] gives proof by showing that the diagonal and the side of a square are incommensurable, and he deals with the questions which arise regarding commensurability in Book V. It is true that, for practical purposes, owing to the

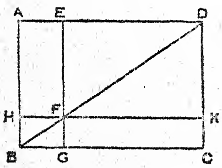
imperfections of our senses, all magnitudes may be considered as approximately, even though not really, commensurable; and hence in *art*, though not in *science*, a means which gives a degree of precision that may be accepted as conventionally accurate may be adopted. Thus, though not mathematically exact arithmetical illustrations of the coincidence of the results arising from the square *of* a number and that of a square *on* a line may be used, and algebraic forms of demonstration may be adopted; yet the geometrical idea ought to be kept sharp and distinct, and the method of Euclid should be studied and known. The analogy which exists between the results of the first ten propositions of Book II. with some of those derivable from arithmetical calculation and algebraic computation make it necessary to emphasize this distinction.

When a straight line is divided into two parts, Euclid calls each part a segment (Lat. *segmentum*, a piece cut off). We had better define this term more explicitly.

Definition 2.—When a straight line (or a straight line produced) is cut in a point (or has any point taken in it, whether internal or external), the distances between the point of section and the ends of the line are called segments of the line. If (1) the point is taken *in* the straight line itself it is called an *internal* segment, if (2) in the line produced, an *external* segment. A line is therefore the *sum* of its internal, the *difference* of its external segments.

For practical purposes in demonstration we require here to define a *gnomon*.

Definition 3.—In every parallelogram any of the parallelograms about a diameter, together with the two complements, is called a gnomon [see I. 43].



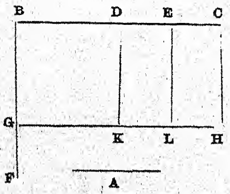
Thus the parellelogram H G, together with the complements A F, F C, is the gnomon, which is more briefly expressed by the letters A G K, or E H C, which are at the opposite angles of the parallelograms which make the gnomon.

The eight earliest demonstrations are devoted to showing, by actual reasoning, that the whole area of every figure in each case is equal to all the parts of it taken together, and *vice versâ* all the parts taken together are equal to the whole, which might be almost regarded as *axiomatic*.

Proposition I.—Theorem.

If there be two straight lines, one of which is divided into any number of parts, the rectangle contained by the two straight lines is equal to the rectangles contained by the undivided line, and the several parts of the divided line.

Let A and B C be two straight lines, and let B C be divided into any number of parts, *e.g.* B D, D E, E C, in the points D and E. Then, the rectangle contained by the two straight lines A and B C shall be equal to the rectangle contained by A and B D, together with that contained by A and D E, and that contained by A and E C.



Construct thus:—From the point B draw B F at right angles to B C (I. 11), make B G equal to A (I. 3); through G draw G H parallel to B C (I. 31), and through D, E, and C draw parallels to B G, meeting G H in K, L and H. Then the *four* figures B H, B K, D L, and E H are each rectangles (I. 46), for C E L, E D K, and D B G are each (I. 29) equal, and D B G is a right angle. As (I. 34) B G, D K, and E L are each equal to A, the rectangle B H is contained by A and B C, and it is equal to the rectangles B K, D L, and E H taken together. Wherefore if there be two straight lines, &c. Q.E.D.

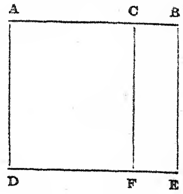
A similar process of demonstration will enable the student to extend this proposition thus:—If two straight lines be each of them divided into any number of parts, the rectangle contained by the two lines is equal to all the rectangles contained by all the parts of the one, taken separately, with all the parts of the other. In other words, the area of a rectangle whose base is the *sum* of any given number of segments is equal to the sum of those rectangles which have these segments separately as bases.

If this Proposition has been rightly understood it will appear at once that the two succeeding theorems are in reality merely corollaries of it. These are—

Proposition II.

If a straight line be divided into any two parts, the rectangles contained by the whole and each of the parts are together equal to the square on the whole line.

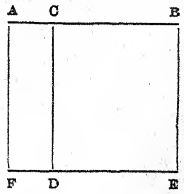
Let the straight line A B be divided into any two parts at the point C: the rectangle contained by A B, B C, together with the rectangle A B, A C, shall be equal to the square on A B. On A B describe the square A D E B (I. 46); and through C draw C F parallel to A D or B E (I. 31). Then A E is equal to the rectangles A F, C E. But A E is the square on A B. And A F is the rectangle contained by B A, A C, for it is contained by D A, A C, of which D A is equal to B A; and C E is contained by A B, B C, for B E is equal to A B. Therefore the rectangle A B, A C, together with the rectangle A B, B C, is equal to the square on A B. Wherefore, if a straight line, &c. Q.E.D.



Proposition III.

If a straight line be divided into any two parts, the rectangle contained by the whole and one of the parts is equal to the rectangle contained by the two parts, together with the square on the aforesaid [i.e. *formerly taken*] *part.*

Let the straight line A B be divided into any two parts at the point C: the rectangle A B, B C shall be equal to the rectangle A C, C B, together with the square on B C. On B C describe the square C D E B (I. 46); produce E D to F, and through A draw A F parallel to C D or B E (I. 31). Then the rectangle A E is equal to the rectangles A D, C E. But A E is the rectangle contained by A B, B C, for it is contained by A B, B E, of which B E is equal to B C; and A D is contained by A C, C B, for C D is equal to C B; and C E is the square on B C. Therefore the rectangle A B, B C is equal to the rectangle A C, C B, together with the square on B C. Wherefore, if a straight line, &c. Q.E.D.



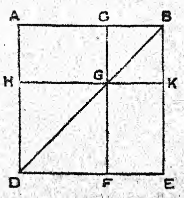
Euclid has not in this book made any distinction between *equality* and *identity*. If he had not chosen to exhibit the equality of the areas compared he might have deduced his next theorem as a consequence from the two immediately preceding. It is very important in practical result.

Proposition IV.

If a straight line be divided into any two parts, the square on the whole line is equal to the squares on the two parts together with twice the rectangle contained by these parts.

Let A B be divided into any two parts in C. Then the square on A B shall be equal to the squares on A C, C B, together with twice the rectangle contained by A C, C B.

On A B describe (I. 46) the square A D E B; join B D; through C draw C G F parallel to A D or B E (I. 31), meeting B D in G and D E in F; and through G draw H G K parallel to A B or D E, meeting A D in H and B E in K. Then the exterior angle B G C is equal to the interior and opposite angle D B A (I. 29). But B D A is equal (I. 5) to D B A, wherefore B G C equals D B A [*i.e.* G B C], and the sides (I. 6 and 34) B C, C G, and G K, K B are equal, and the figure C G K B equilateral and (I. 46) rectangular [*i.e.* it is a square]. For



similar reasons H F—upon the side H G equal to A C (I. 34)—is also a square. Therefore the figures H F, C K are the squares on A C, C B. And as the complement A G [*i.e.* the rectangle A C, C B] is equal to the complement G E (I. 43), [*i.e.* the rectangle A C, C B], A G and G E are equal to twice the rectangle contained by A C, C B; wherefore the four figures H F, C K, A G, G E are equal to the squares on A C, C B, and twice the rectangle contained by A C, C B. But these four figures make up the whole figure A D E B, which is the square on A B. Wherefore, &c. Q.E.D.

It is obvious to remark that the main thing requiring demonstration in this proposition, viz. that the parallelograms [C K, H F] about the diameter of a square are also squares, might have been proved very shortly by using the corollary to I. 46—"every parallelogram that has one angle a right angle has all its angles right angles."

This proposition—which may be otherwise stated thus: *The square on a straight line is greater than the sum of the squares on its internal segments by twice the rectangle contained by these segments*—yields the following corollaries: (1) If the two parts of a divided straight line are equal, the square on the whole line is equal to four times the square on one half of the line; (2) the parallelograms about the diameter of a square are likewise squares; and (3) if a line be divided into any three parts, the square on the whole line is equal to the squares on the three parts, and twice the rectangle contained by every two parts.

The next two theorems are given thus in the elements:

Proposition V.

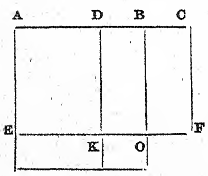
If a straight line be divided into two equal parts and also into two unequal parts, the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

Proposition VI.

If a straight line be bisected, and produced to any point, the rectangle contained by the whole line thus produced, and the part of it produced, together with the square on half the line bisected, is equal to the square on the straight line which is made up of the half and the part produced.

But both of these propositions may be generalized into, and be made corollaries of, this theorem:—*The rectangle contained by the sum and difference of any two lines is equal to the difference of the squares on these lines*, which is easily proved by constructing the rectangle and completing the figure, thus:—

Let A B, B C, be any two lines, then (1) A C is the *sum* of these lines, and if B D be taken equal to B C, (2) A D is their *difference*. By drawing A E equal to A D at right angles to A C, and completing the rectangle A E F C, the rectangle contained by A C, A D, will be found to be formed by the sum and the difference of A B, B C. Next describe the square A G H B on A B, and through D draw D K L parallel to A G, and K H is the square on B C. Then D F is equal to D O and B F. Now the difference of the squares on A B, B C, is the figure made up of A O and E L, which is equal to the figure made up of A O and B F, that is to A F, which is the rectangle contained by the sum and difference of A B, B C. Q.E.D.



Proposition VII.—Theorem.

If a straight line be divided into any two parts, the squares on the whole line, and on one of the parts, are equal to twice the rectangle contained by the whole and that part, together with the square on the other part.

This is an easy deduction from Prop. IV., which see.

Let A B be divided in C; on A B describe a square A D E B; through C draw C F parallel to A D, from A D cut off A H equal to B C, and through H draw H G K, parallel to A B. Then A G, C K, G E, H F are rectangles, by construction, of which H F, C K, are the squares on A C, C B, and A G, G E are each rectangles contained by A C, C B. But the square A D E B is made up of these four figures, and therefore the square on A B is equal to the squares on A C, C B, and twice the rectangle contained by these lines. Q.E.D.

Proposition VIII.

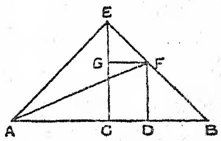
If a straight line be divided into any two parts, four times the rectangle contained by the whole line and one of the parts, together with the square on the other part, is equal to the square on the straight line which is made up of the whole and that part [i.e. the square on the sum exceeds the square on the difference by four times the rectangle contained by the lines.]

Stated in the latter form, it becomes a special case of the theorem demonstrated under Props. V. and VI. See diagram, II. 6.

Proposition IX.

If a straight line be divided into two equal, and also into two unequal parts, the squares on the two unequal parts are together double of the square on half the line and of the square on the line between the points of section.

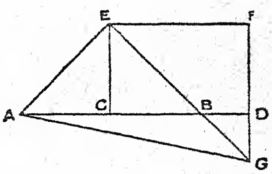
This is really a case of Propositions IV. and VII., and may be deduced directly from them. Euclid's demonstration is ingenious, but indirect and tedious. Its steps are: (1) A E B is a right angle, (2) E G = G F, (3) D F = D B, (4) the square on A E = double of square on A C, (5) the square on E F is double of square on C D, (6) the square on A F is double of squares on A C, C D, and (7) the squares on A D, D B, are double the squares on A C, C D.



Proposition X.

If a straight line be bisected, and produced to any point, the square on the whole line thus produced, and the square on the part of it produced, are together double of the square on half the line bisected and of the square on the line made up of the half and the part produced.

This is also a case readily solved directly from Propositions IV. and VII. In reality Props. IX. and X. are *identical*, although, as figured, stated, and worked they seem different, and the steps in Euclid's demonstration follow exactly, point by point, the seven noted in the preceding proposition. A E B is a right angle; E C = C B; B D = D G, and the squares on A E, E B, and B G are respectively equal to double of the squares on A C, C B, and B D, which together constitute the bisected straight line and the produced part.



These ten propositions constitute the general matter of Book II. But the special applications of the truths thus advanced remain to be considered.

BOTANY.—CHAPTER XIII.

CRYPTOGAMIC PLANTS—CELLULAR AND VASCULAR SEAWEEDS—FUNGI—LICHENS—CHARA—MOSSES AND LIVERWORTS—FERNS—HORSETAILS, ETC.—BOTANICAL RESEARCH.

The great Swedish naturalist to whom we owe the creation of a fixed and well-defined language of botany, and the highly valuable example of always employing the same word in the same sense, and always expressing the same sense by the same word, has won a fairly-earned renown by the skill and felicity with which he provided those clear and precise descriptive terms by which the student of the vegetable creation can communicate and receive exact knowledge regarding the form and structure of plants. It is true that, of late, what has been somewhat harshly denominated "the Babel of Botany" has been greatly increased by the acquirement of fresh knowledge and the recognition of nicer distinctions—that new terms are being introduced, and old terms are

receiving greater strictness of denotement and implication. Of course this is a necessary consequence of the specialism which is becoming more and more the rule in every department of research, and which has recently led to the devotion of so much skilled investigation to the elucidation of the facts of plant-life in regard to (1) structure, (2) development, and (3) distribution. The wonderful energies imprisoned in the most seemingly simple, microscopic, protoplasmic speck —the structural unit of plant-life—as it evolves through the complexities of assimilative feeding, accumulative growth, and ultimate reproductiveness have always excited curiosity; but in our day cryptogamic botany has received special attention as containing the key to vegetable morphology, if not also to the evolution of living forms in general.

Cryptogamic Botany concerns itself with those members of the vegetable world which do not present to the eye of the observer perceptible flowers. The prominent distinction of evident flower-bearing or *phanerogamous*, and not-evidently flower-bearing or *cryptogamous* plants, Linnæus adopted as a strictly natural one. But the signification of the word *flower*, in this connection, must be greatly extended beyond that of those pleasing ornaments of vegetable origin of which bouquets are made. Every plant which bears a fruit, and is consequently a seeded plant, is botanically considered a flowering plant, and those which produce *sporules* or *spores* as the means of their reproduction are regarded as flowerless plants. They have no distinct anthers or ovules. Jussieu designated them *Acotyledons* (without seed leaves). Lindley divides them into two classes—(1) *Acrogens*, and (2) *Thallogens*, in the former of which root, stem, and leaf are usually distinctly developed, while in the latter these parts are not obviously distinct. De Candolle gives them the name of *Cellulares* (consisting of cellular rather than vascular tissues). The Cryptogamia, in this classificatory aspect, are a great and somewhat heterogeneous assemblage of plants including ferns, mosses, lichens, seaweeds, &c., among their classes and orders, and not so capable of exact and popular description as their flower-showing compeers. They may, with a certain degree of distinctness, be defined (1) negatively, as plants exhibiting no true stamens or pistils; and (2) positively, as plants whose fertilization is accomplished by means of motile ciliated particles, which may be called *phytozoa* or *spermatozoids* (*i.e.* reproductive cells which possess a specialized structure, and perform a similar function, in the economy of the Cryptogamia, as seeds do in the Phanerogamia). It has of late been found advisable to divide these into two classes—(1) *spores* or *cells*, which are made reproductive by an act of direct or indirect impregnation—*e.g.* the reproductive cells of ferns, and (2) *conidia* or *gonidia*, rounded non-sexual reproductive unicellular bodies, like those seen in the fungi.

Cryptogamous plants are not distinguishable as a class apart, absolutely, by any single characteristic, but rather by a combination of several distinguishing peculiarities. They exhibit very different degrees of organization from the lowest or least complete plant-forms, consisting of simple isolated, roundish, membranous sacs or cells, in which no distinction between the nutritive and the reproductive functions is observable—*e.g.* the Red Snow (*Protococcus nivalis*)—up to the highest or most complete, which show both stem and leaves, and even a peculiar sort of fibro-vascular woody structure—*e.g.* the Adder's-tongue Fern (*Ophioglossum vulgatum*).

The actual practical distinctions of the classes and subclasses into which Cryptogamia are divisible can only be made out by students well acquainted with vegetable anatomy and thorough adepts at microscopical observation. They are necessarily classified and arranged differently by different schools of botanists, according to their preference for logical or biological lines of demarcation. A fine biological classification is that into (1) *Thallophyta*, (2) *Bryophyta*, and (3) *Pteredophyta:* the first class possess neither stem nor leaves, the other two do both; the last exhibit fibro-vascular bundles and roots, the other two do neither. One author divides them into (1) *Aetheogams*, having air-vessels and air-pores; and (2) *Amphiogams*, having neither; and another into (1) *Thallogenæ*, and (2) *Acrogenæ*, the latter exhibiting root, leaf, and stem, the former not showing them.

Probably the best and easiest classification is that in which they are regarded as forming four pretty well-known natural groups—viz. (1) *Thallophytes*, including Algæ, Fungi, and Lichens; (2) *Characeæ*, including Chara and Nitella; (3) *Muscineæ*, including Hepaticæ and Mosses; and (4) *Vasculares*, including (*a*) Ferns, Equisetaceæ, and Ophioglossaceæ, bearing one kind of spore; and (*b*) Rhizocarpeæ and Lycopodiaceæ, bearing two kinds of spores, large and small. These classes, though it may be difficult to describe or define them in words, are, as a general rule, pretty clearly distinguishable one from another by observers of ordinary capacity, even when, in regard to minute biological differences, they have not been able to perceive the thin partitions which divide the several subclasses.

I. Thallophytes, as Eudlicher calls them, *Thallogens* of Lindley and others, are those acotyledonous plants which display the most simple vegetable structure, and consist of a mere thallus with reproductive powers. A *thallus* is a more or less flattened expansion of cellular tissues, separate or combined, but having no woody fibre. Thallophytes exhibit no morphological distinction between stem and leaf, the mode of their reproduction is varied, but the classes in which they are arranged are regarded as quite provisional. We may call them (1) *Protophyta*, the simplest and smallest plants with which we are acquainted. They are capable of vegetable multiplication by separation or division, and hence Cohn has called them *Schizophyta*, *e.g.* the mouiliform threads of the Nostocaceæ, the cellular Bacteria, the straight-celled Bacillus, the curve-celled Vibrio, &c. (2) *Zyosporeæ*, which multiply by conjugation of cells, of which the product is *plasmodium*. This plasmodium develops into sporocarps and spores, as the unicellular alga Pandorina, which swims about in colonies of sixteen or multiples of sixteen; and the whole family of the Diatomaceæ (taken either from fresh or salt-water), whose beautiful silicious cell-walls form a very instructive object under the microscope. (3) *Oosporeæ*, in which there is developed (*a*) the *oogonium* or female oospheres, and (*b*) the *antheridium* or male spermatozoid case. These, after conjunction, result in oospores, which either grow directly into fresh plants or develop into zoospores, as the *Volvox globator*, a nearly globular minute organism found in stagnant water, the transparent sphere of which is visible to the naked eye, and is often seen studded with innumerable green spots, forming a very beautiful network of vegetable tissue; and (4) *Carposporeæ*, in which the sporocarp or spore-fruit (*i.e.* the product of the fertilized organ of reproduction) develops from the carpogonum, as the Florideæ or Red Algæ, whose fine red or violet colour (due to the presence of phycoerythrim) gives a glow to marine waters. These morphological characteristics are encumbered with many technical difficulties not suitable for popular exposition, and we must content ourselves here with rather describing easily recognized families than defining subtle peculiarities.

1. *Algæ*—plants living in the sea, in fresh water, in stagnant pools, in hot springs, and in moist earth—present the simplest forms of plant-life—nothing, in fact, but a cell-wall containing a coloured protoplasmic substance. Protoplasm is the nucleus, and chlorophyll, in grains or bands, occurs in the higher kinds. Lignification does not take place in any of them, but, in some cases, slight differentiations into distinct organs occur. The forms they assume, and into which they may combine—globose, laminar, linear, mouiliform, &c.—are more various than in any other class of plants. Their mode of branching is generally either (1) monopodial [*i.e.* single], or (2) dichotomous [*i.e.* twofold]; and among them alternation of modes of reproduction is common—that is, both sexual and asexual reproductiveness takes place; for example, in Diatomaceæ and in Œdogoniaceæ, three modes of generation occur, and in the Coleochæteæ, four dissimilar forms of generation have been observed.

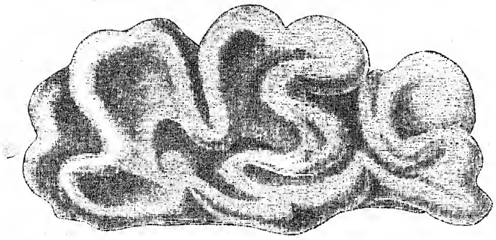
Seaweeds are furnished with a double system of fructification. The majority of the red series have this double fructification, the capsular on one plant, and the granular on the other. Many modifications of shape exist. But there is a unity of principle, so that they are at once alike and unlike. Dr. Lindley says: "I am very much inclined to adopt the opinion that the two sorts of fructification ob-

BOTANY.

PLATE XI.

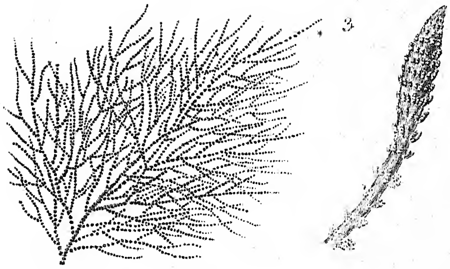
ALGÆ

2



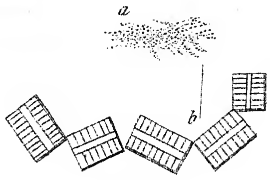
Nostoc.

3



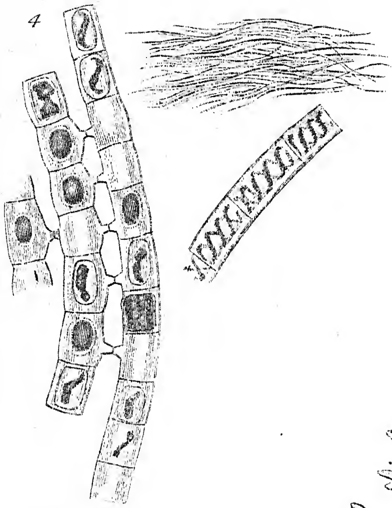
Batrachospermum atrum.

1.



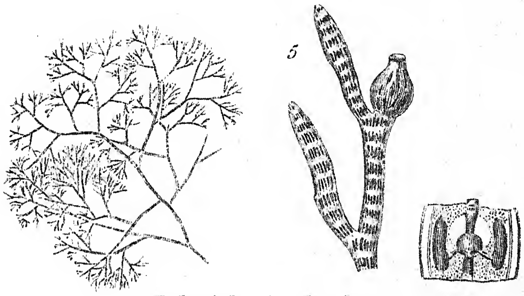
Diatoms.

4



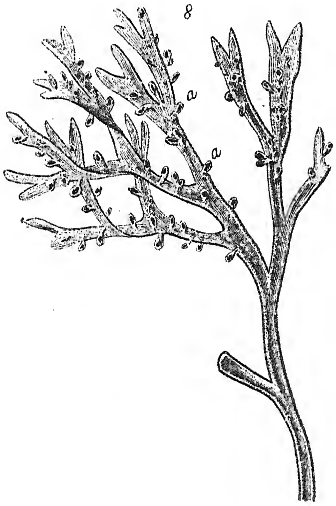
Spirogyra.

5



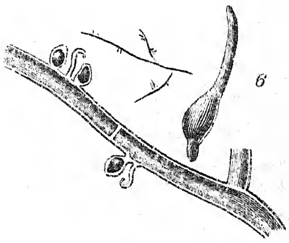
Polysiphonia fastigiata.

8



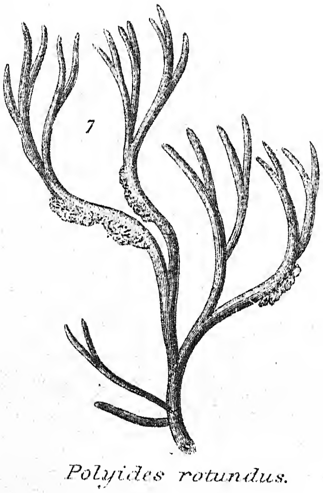
Gigartina mammillosa.

6



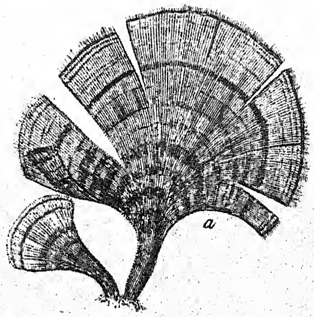
Vaucheria.

7



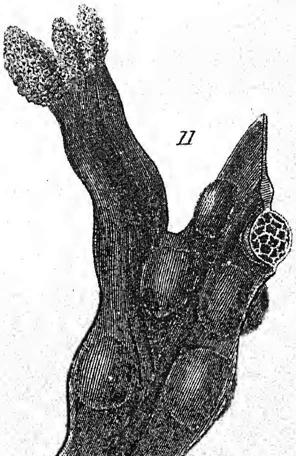
Polyides rotundus.

9



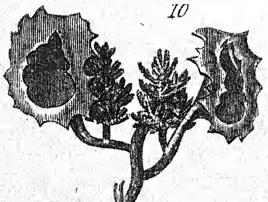
Padina pavonia.

11



Fucus vesiculosus. (bladder-wrack)

10



Hydrodictyon. (water-net)

servable in Algæ are the first attempts at the agency which, in higher plants, performs the office of sexes, without, however, having their qualities established, and each capable of producing a new plant without the aid of the other."

As the eye may notice at once what might require many words of description, the student will find figured in Plate XI. some of the most typical forms of Algæ. In fig. 1 are seen regular and symmetrical arrangements of those singular groups of minute organisms which are found in salt and fresh water, on the surface of damp rocks and walls, the glass of hothouses, garden paths and flower-pots, known as the Diatomaceæ—dotted, striated, and marked in various modes—which receive their name from their multiplication by longitudinal division. They die and rapidly putrefy, but their flinty valve-shells resist decomposition better and longer than any organic product. The Nostocaceæ (fig. 2) form strings of cells inclosed in sheaths of gelatinous matter. These sheaths melt into jelly-like masses as figured. To the group of the Florideæ belongs the *Batrachospermum atrum* (fig. 3). This is almost the only member of that group which grows in fresh water. It is black, but nearly all the sea genera have a reddish shade. The Spirogyra (fig. 4), so named from the spiral form its bands of chlorophyll take, appear in threads, and conjugate by the union of two cells on opposite threads. We represent the form, though we do not reproduce the tint, of the rose-coloured spores of the *Polysiphonia fastigiata* (fig. 5), whose thread-like, jointed, and striped-looking fronds grow on the *Fucus nodosus*. The tufts of the Vaucheria (fig. 6) are dark green. Its single-cell threads are branched, and the ends of the branches detach themselves as spores. Antheridia and oogonia are found on the same branch. The rose-hued spores of the *Polyides rotundus* (fig. 7) are large and conical. They are attached by the small end, many together, and radiating out from a single point they form a spongy mass of jointed threads familiar to those who dwell upon the coast. The firm, jelly-like substance which encases the numerous threads of the branching fronds of the *Gigartina mammillosa* (fig. 8) occurs usually among Carageen or Irish moss. Its spores appear in roundish masses in capsules on the outside of the plant. Though the Peacock's Tail (*Padina pavonia*, fig. 9) is a native of the tropics, yet as it reaches the British shores we show its beautiful feather-like form. It is placed in contrast with the flat-forked frond of the well-known Bladder-wrack (*Fucus vesiculosus*, fig. 11) and the Water-net (*Hydrodictyon*, fig. 10).

As upwards of 2000 species of Algæ are known, and as these vary in size from mould-like forms visible only through the microscope to the Luminariæ, which float on the seas surrounding South America, 100 feet in length, the *Macrocystis pyrifera* of the Pacific, 1500 feet long, or the *Lessonia fuscescens*, attaining the thickness of a human thigh, it is obvious that a volume rather than a chapter would be required to secure the adequate treatment of this topic. To this let us add that their *habitat* is exceedingly various. The *Sarcinula ventriculi* occurs in the stomachs of men and animals, the *Achlya prolifera* on the gills of fish, and the Gulf-weed (Sargassum) floats in the Sea of Mexico in such abundance as to transform its surface into the appearance of a meadow of marvellous greenness.

2. *Fungi* are cellular plants nearly related to the Algæ. Their cells are sometimes so elongated as to become filamentous. They consist of a *thallus*, called scientifically *mycelium* (mushroom-like), and vernacularly the spawn, as ergot, dry rot, &c. Unlike Algæ and lichens, they have roots, and derive their nourishment from what they grow upon, and they have no green granules (*gonidia*) in their thallus. From this thallus stems are sent up into the air and bear the organs of fructification. They are in general highly nitrogenous in their composition, and to their *mycelia* the *motheriness* of liquors is due, as well as the ropiness of baker's dough. Their parts are (1) the *mycelium* or spawn, (2) the *volva* or wrapper, (3) the *stipes* or stalk, (4) the *annulus* or ring, the remains of the indusium which inclosed (5) the *pileus* or cap at the top of the stalk, (6) the *lamellæ* or gills of (7) the *hymenium*, to the layers of which the spores are attached. The spores are borne on simple or branched processes called sporosphores, or basidia, or are contained in thecæ or asci, accompanied by other bodies called antheridia or paraphyses. The true fruct is formed on two plans. In one the tips of certain threads swell into

Eatable Agarici.

Poisonous Agarici.

bodies surmounted by little spicules which each give rise to a single cell. This mode is called acrosporus; in such cases the spore ultimately falls off. In the other method certain threads swell out and form bags or tubes containing eight spores, or a multiple of that number. This mode is called ascigerous. Some fungi are used for food and for making sauce, while others are poisonous.

3. *Lichens* consist of a *thallus*, which may be either crustaceous, foliaceous, or fruticose, and reproductive organs; (1) *Apothecia* or *lirellæ*, that is elongated cells which contain the spores, and (2) *Spermagonia* or spermatic cells, and (3) *Pycnides*, which give rise to spore-like bodies called stylospores, whose function is undetermined. The recent researches of Schwendener seem to show that lichens are really Algæ, with parasitic fungi upon them. Probably the whole botany of lichens will soon undergo considerable modification. Nylander's fourfold classification prevails at present. Both in a medicinal and an industrial point of view they are highly important. Meanwhile it may not be disadvantageous to note that wherever lichens are seen in large numbers and in vigorous growth we may be sure that the air is pure and wholesome, for only in such an atmosphere do they flourish.

II. Characeæ constitute a highly interesting group of plant-forms owing to the readiness with which, under the microscope, they exhibit the phenomena of protoplasmic motion. They grow in pools and slow-running streams, and impart a nasty odour to them. They root in mud, and often entirely conceal muddy bottoms by the growth of their slender, brittle, tubular stems, which are either pellucid or encrusted with carbonate of lime, and give off at intervals whorls of symmetrical branches of a similarly tubular structure. The reproductive organs, which have considerably puzzled botanists to understand, are of two kinds:—(1) Lateral *globules*, the walls of each of which is composed of eight cells called the *shields*. From each shield a cell projects, called the *manubrium*, at the inner end of which occur six small heads, and from each of these heads four coiled threads grow, partitioned off into cells, in each of which an antherozoid is formed; (2) axillary *nucules*, large and oval, which, on being fertilized by the antherozoid, drop off to germinate in the mud. The oospore thus formed develops, first, into a thread-like body, called the pro-embryo, and from one of the cells of that there springs up a new plant.

Of Characeæ there are two species—(1) *Chara*, in which the nucule rises from the base of one of the whorl leaves, and is therefore above the globules; and (2) *Nitella*, in

which the nucule is formed upon the leafy axis, and is therefore beneath the globules. These plants have no known use, but they possess some interest from the fact that Sir David Brewster first observed in them the beautiful phenomena of *cyclosis* [*i.e.* the movements of the contents of cells in plants] from which much is yet to be learned regarding protoplasmic development and differentiation.

III. MUSCINEÆ display that process of development usually termed alternation of generation, in which successive differing forms of reproduction occur in the process of growth, though ultimately returning to the original form. In Mosses (*Musci*) the sexual generations are produced from a filamentous pro-embryo [or *protonema*] as lateral shoots. Upon this leaf-bearing axis the organs of fructification arise (1) at the apex (acrocarpous), or (2) at the side (pleurocarpous); but the asexual generation originates from the oospore (commonly called the fruit) of the moss. This oospore enlarges into an ovoid embryo termed the *sporogonium*, which presses against the *epigone*, ruptures it, pushes its upper part forward as the calyptra or cap, and forms at the base, with its lower portion, a sheath. This lower part acts as a *seta* or supporting stalk, while the upper part makes a capsule urn, or *theca*, the walls of which consist of several layers of cells. The central axis or columella of this capsule is surrounded by spores. When ripe the capsule opens by valves or a lid, and the spores are shed. These germinations originate a pro-embryo, and that by budding gives off sexual plants. In Hepaticæ (Liverworts), which have generally a leafy stem, the reproductive organs are (1) *antheridia* and (2) *pistillidia*. Their capsules (spore-cases containing matured pistillidia) open by valves when ripe, and the spores are ejected thence by *elaters* [*i.e.* filaments coiled up in oval cells], which, when the spore-cases burst, spring out elastically and disperse the spores. From the spore of the asexual generation a small pro-embryon is first formed, but sexual generation may take place directly. Both mosses and liverworts present most beautiful forms. The former are divided into four orders, (1) *Sphagnaceæ*, (2) *Andreæaceæ*, (3) *Phascaceæ*, and (4) *Bryaceæ;* the latter into five, (1) *Anthoceroteæ*, (2) *Monocleæ*, (3) *Riccieæ*, (4) *Marchantieæ*, and (5) *Jungermannieæ*. The distinctions between these are dependent upon many minute details, into which we cannot enter here.

Of the very interesting family of the Mosses we give some examples in Plate XII. Of the single species Sphagnum (fig. 1) a ripe spore-case is shown at *a*, and the whole spongy plant surmounted by its sporogonia. At fig. 2 Phascum is exhibited in its natural size; at *a* it is shown enlarged, and *b* represents the spore-case with its calyptra detached. Pottia (figs. 3 and 4) is one of the most numerous class of the mosses, Bryaceæ. It is acrocarpous. Its capsules (3*a* and 4*a*) are of elongated oval form, and its leaves large-celled; *a* shows the lid, *b* the calyptra, and 4*c* is an enlargement of 4. *Splachnum mnioides* (fig. 5) is also acrocarpous. The apophysis (shown in 5*a*) is in some species shaped like a top, in others it resembles a Turk's-cap gourd, and in some looks like an umbrella. Pottia, Splachnum, and Grimmia (fig. 6) have each at the top of the capsule (fig. 6*b*) a *peristome*, 6*c*, with sixteen appendages called teeth. Fig. 6*a* is an enlargement of fig. 6. Another peristome with sixteen teeth occurs in Dicranum (fig. 7), in which the urn (*a*) is unequal, the calyptra (*b*) split, the lid (*c*) beaked, and the teeth (*d*) bifid. Tortula (fig. 8) has thirty-two teeth twisted into a common bundle, and is apocarpous. The parts are given enlarged at *a*, *b*, *c*, and *d*, as they are also in Orthotrichum (fig. 9), which exhibits a striated capsule, *b*, a beaked lid, *a*, a bell-shaped calyptra, *c*, and a peristome with broad flat teeth, arranged in eights and sometimes double. Of the higher genera of mosses the Ptychomitrium (fig. 10) has an erect regular urn, *a*, a deeply-furrowed pointed calyptra, *b*, a beaked lid, *c*, and a single peristome of sixteen equidistant bifid teeth, *d*. The genus Bryum (represented by *Mnium hornum*, fig. 11) has a pendulous urn, *a*, with a double peristome, the outer of sixteen teeth, the inner a membrane divided halfway into sixteen segments, *b*. The genus Bartramia (fig. 12) has a globose striated urn, *a*, with or without a peristome, sometimes double, the inner consisting of a membrane divided into sixteen processes splitting along the middle, sometimes with cilia, *b*, the outer consisting of sixteen equidistant teeth, *c*. A careful study of the plant-forms of mosses, as here shown, will, better than pages of description, impart an idea of the likenesses and differences of those miniature miracles of vegetation.

IV. VASCULAR CRYPTOGAMS.—1. Of the vascular Cryptogamia none have so acquired favour and induced culture like the fern. Its delicate and graceful outlines, its wonderful seed structure, and its delightful greenness charm every observer. All true ferns, from the most simple herbaceous—*e.g.* wall rue—to the most complex of arborescent forms—*e.g.* the tree-ferns—are known by the circinate growth of their young leaves, and have their sporangia developed on the under side of their leaves in clusters, called *Sori*, which differ in form and position in the different genera. Spores are produced within the sporangia, which may be either stalked or sessile, and formed from the epidermis on the back (Asphidium) or edges (Pteres) of a frond, which is rolled up on itself from the top downwards, like the ornamental head of a bishop's crozier. When ripe the spores escape by the rupture of the spore-case. Each spore is divisible into an outer layer or exospore and an inner or endospore, and germinates on reaching the soil. Then the endospore divides, forms a flattened cellular expansion (or *prothallus*) with small cellular rhizoids, and on this produces the organs of fructification, *antheridia* and *archegonia*, by whose mutual influence an oospore is formed. From this an asexual generation arises, and thus in ferns two dissimilar modes of reproduction alternate: (1) a prothallic or sexual and (2) an asexual one. The study and culture of ferns may be commended to the student of botany, although the classifications are as yet artificial, and their physiology is the object of earnest special investigation still.

2. *Equisetaceæ* have the prothallium above ground and green; the leaves are simple, in whorls, and form sheaths. The sporangia occur in groups on the edge of (metamorphosed) leaves, and are produced as a terminal ovoid (egg-shaped) fructification, forming a pyramidal mass of polygonal scales, having spores on their under surface. These are ejected from the sporangia by elastic filaments.

3. *Ophioglossaceæ* have the prothallium underground and not green, and their sporangia on a branch of the leaf, as in adder's tongue and mousewort.

4. *Rhizocarpeæ* have their sporangia produced in *sporocarps* (ovoid sacs or receptacles). Their sporangia produce macrospores and microspores. In the macrospores a prothallium is formed, and from the oospores produced in it the embryos originate, as in the *Isoëtes lacustres* and the *Pillularia globulifera*.

5. *Lycopodiaceæ* have not their sporangia hypophyllous, but they appear near the base on the upper side of the leaf. The whole fructification frequently forms a spike, and the mode of their embryogency appears to form a connecting link between the cryptogams and the angiosperms.

Of late years the tendency of botanical study has been rather to devote special attention to the Cryptogamia than the Phanerogamia, and to histology rather than physiology. In such a condition of things, many keenly debatable points arise unfitted for popular exposition and incapable of being reduced to dogmatic statement. To endeavour to expound to the tyro in botany the recondite investigations now in process in regard to cryptogamic structure and fructification, would be highly injudicious. There is enough in the known facts of botany to interest and instruct. The student who learns these will soon acquire an inclination to follow the researches of specialists in the line which he likes most.

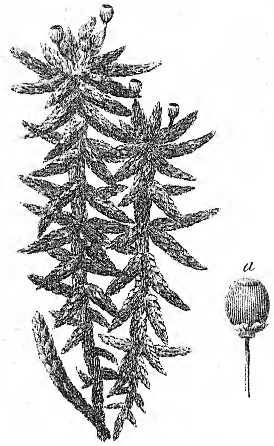
THE GERMAN LANGUAGE.—CHAPTER XV.

HINTS ON TRANSLATION AND COMPOSITION—THE SPECIALTIES OF THE SUBJUNCTIVE AND CONDITIONAL MOODS—THE CHARACTERISTICS AND USEFULNESS OF GERMAN—CONCLUSION.

IN the study of German sentences the most important point is to learn to distinguish the principal clause, and, having found that, to fix the attention on discovering (1) the *subject*, and all that is connected with it; (2) the *verb*, whether

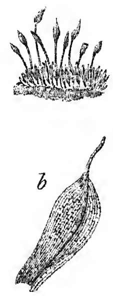
BOTANY.

MOSSES.

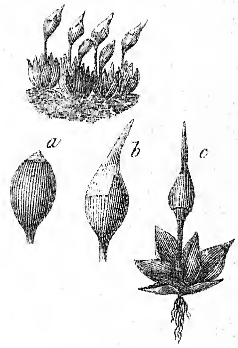


1 *Sphagnum.*

2 *Phascum*

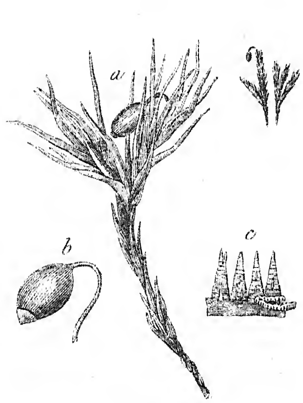


3 *Pottia.*

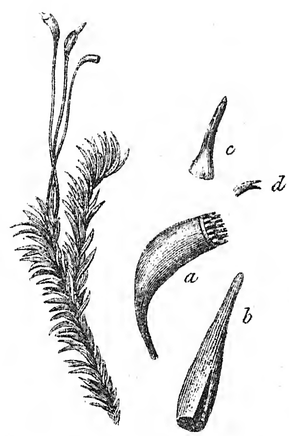


4 *Pottia.*

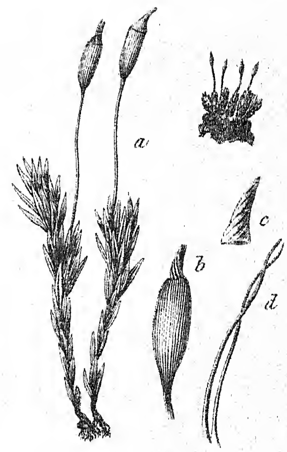
5 *Splachnum. Mnioides.*



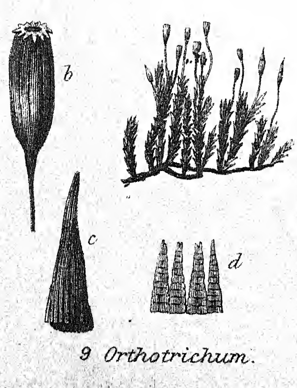
6 *Grimmia.*



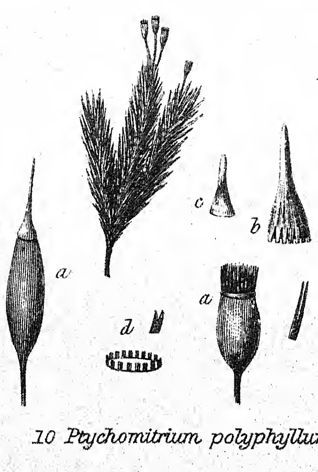
7 *Dicranum.*



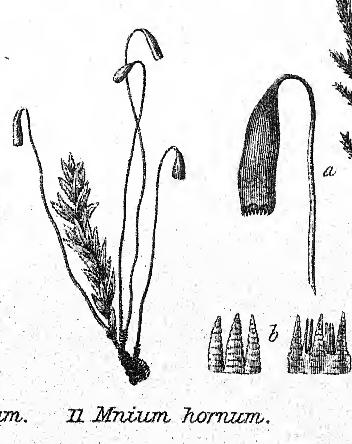
8 *Lortala.*



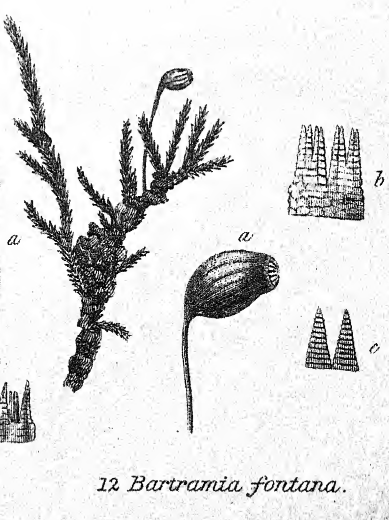
9 *Orthotrichum.*



10 *Ptychomitrium polyphyllum.*



11 *Mnium hornum.*



12 *Bartramia fontana.*

simple or compound, or in a tense that is simple or compound; (3) the *object*, direct or indirect (or both) of the verb; (4) any adverb, or adverbial phrase, affecting the signification of the verb; and (5) any accessory clauses, coordinate or subordinate, dependent on the verb. In the student's endeavour to resolve or analyze a sentence into its parts in a clear and careful manner—*e.g.* after the models exhibited on pages 1104 and 1105—the following hints may be found useful:—

1. If the subject stands first in the sentence (with all its belongings, of course, attached to it), and the verb consists of a simple tense, the syntactic construction will usually be similar to that of a simple English sentence; as Der Neid ist der Schatten des Ruhmes, Envy is the shadow of renown; Die Inseln sind die Berge des Meeres, Islands are the mountains of the sea; Cäsar wußte eben so gut mit der Feder als mit dem Schwerte umzugehen, Cæsar could manage just as well with his pen as with his sword.

2. If a sentence begins with the subject, and the verb appears in a compound tense, then the past participle, the infinitive (or both), forming the predicative term, should be sought for at the close of the sentence; as Der Nagel wird von mir in die Wand geschlagen, The nail is struck by me into the wall; Sie müssen alle Ihre Gedanken auf Ihr Geschäft richten, You must turn all your thoughts upon your business; Ich hatte das Vergnügen, das Laster bestraft und die Tugend belohnt zu sehen, aber es war nur in einem Lustspiele, I had the pleasure of seeing vice punished and virtue rewarded—but it was only in a comedy.

3. When a sentence contains an auxiliary verb and (1) a predicative adjective, or (2) a simple verb with a separable particle, the adjective or particle will generally be found placed at the end of the sentence; as (*a*) Ich bin heute mit meinem Freunde ausgegangen, (*b*) heute bin ich mit meinem Freunde ausgegangen, (*c*) mit meinem Freunde bin ich heute ausgegangen, I have gone out with my friend to-day.

4. In accessory sentences in which an infinitive occurs—whether um precedes it or not—take, in translating, the infinitive from the end; as Wollen Sie so gut sein und mir sagen [or Wollen Sie so gut sein, mir zu sagen] wieviel Uhr es ist? Will you be so kind as to tell me what o'clock it is? Ich komme um Abschied von Ihnen zu nehmen, I am come [in order] to take leave of you.

5. The nominative must be looked for after the verb if a sentence begins (*a*) with a noun in an oblique case, whether governed by a preposition or not, (*b*) a noun (or an adverb) of time, place, or manner, (*c*) an infinitive, participle, or predicative phrase, or (*d*) an accessory sentence; as Die neue Sängerin hat gestern sehr schön gesungen, The new singer sang very beautifully yesterday; Es hat die neue Sängerin gestern sehr schön gesungen, The new singer sang indeed very beautifully yesterday; Gestern (adverb of time) hat die neue Sängerin sehr schön gesungen, Yesterday the new singer sang very beautifully; Sehr schön (adverb of manner) hat die neue Sängerin gestern gesungen, Very beautifully did the new singer sing yesterday; Gesungen (past participle) hat die neue Sängerin gestern sehr schön, The new singer sang yesterday very beautifully.

6. When, without the previously mentioned reason, the nominative appears after the verb in sentences which are not exclamatory or interrogative, some conditioning word (like *if*) is understood [or, if auch, gleich, schon, or any similar word follows the verb, *although* requires to be supplied]; as Es ist, als hätte Niemand etwas Anderes zu thun may be used for Es ist, als ob Niemand etwas Anderes zu thun hätte, It is as if nobody had to do anything else; Ist er gleich [schon or auch] reich, so hat er doch keine Freunde may be used instead of obgleich or Obschon er reich ist, or wenn er auch reich ist, so hat er doch keine Freunde, Although he is rich, he has no friends.

It is scarcely possible to generalize and sum up in a single sentence the foregoing hints on the translation of German into English, so as to make them equally serviceable in the converse process; but if the student reflects on, and thoroughly understands, the following statement, he will find himself helped in his endeavours to arrange the items of an English sentence into the German form.

In the construction of sentences the best writers in Germany generally put the most important of the elements to be incorporated in each sentence last; the less important precedes the more important in regular series, the least important being generally placed before and nearest to the subject and its finite verb. This is the case generally, we have said, because the qualifying particulars may not only differ in importance in themselves, but also in the speaker's own mind and in the special statement to be made. Hence, any element requiring to be raised to superior importance must be brought nearer to the end in the ratio of its intended importance. This may be exemplified thus:—Er hat gestern dem Manne den Brief nicht gezeigt, He has yesterday to the man the letter not shown, *i.e.* as we would say in English, He did not show the letter to the man yesterday.

By varying the phrase, however, we can bring out several distinctions of signification, and bring into emphasis special phases of expression. For example, in the following forms in which, to indicate the sort of constructive meaning implied by the changes in the sentence, a phrase, in brackets, has been illustratively introduced, not because it is required in speaking or writing, but that it may be suggestive to the student of the emphasis of place.

Er hat gestern dem Manne nicht den Brief [sondern das
He has yesterday to the man not the letter [but the
Buch] gezeigt. Er hat gestern den Brief nicht dem Manne
book] shown. He has yesterday the letter not to the man
[sondern seinem Freunde] gezeigt. Er hat dem Manne den Brief
[but to his friend] shown. He has to the man the letter
nicht gestern [sondern heute] gezeigt.
not yesterday [but to-day] shown.

It is, of course, to be remembered that the best style in German, no less than in other languages, is the clearest, the one least liable to be misunderstood, the most easy to be understood; and that in German, above almost every modern language, the *sense* governs the *syntax*. While, therefore, the instructions given point out the most frequent and classical forms of arrangement, it is quite certain that many cases may occur in which sentences differ in the collocations of their words from those noted above. Great freedom is now employed in placing the predicate and its dependent phrases, some rarely ever placing them after the verb, and others scarcely ever putting them before the subject. We have endeavoured to indicate the usual practice. Nobody could reduce to rule all the possible usages of speech.

The subjunctive mood is used in *principal* sentences to express uncertainty, probability, doubt, wish, &c.; *e.g.* Er rede die Wahrheit, und gestehe, daß er gefehlt hat, May he speak the truth, and confess that he has been in error: Ich weiß nicht, ob der Vogel singe, I know not whether the bird may sing.

But particularly in *subordinate* sentences it is used (1) to indicate purpose, *e.g.* Er geht in die Schule, damit er Etwas lerne, He goes to school in order that he may learn something.

(2) To express only a notion, *e.g.* Es ist ungewiß, wenn er zurückkehren werde (*i.e.* seine Rückkehr ist ungewiß), It is uncertain when he will return.

(3) To express a thought quoted by the speaker when the principal sentence contains verbs signifying to say, to repeat, to relate, to believe, to think, &c., *e.g.* Der Knabe sagte, er sei krank, und ich erwiederte, wenn er krank sei, müsse er zum Arzte gehen, The boy said that he was ill, and I replied, if he were ill he must go to the physician; Die Frevler meinen, es sei kein Gott, The wicked believe that there is no God; Cäsar berichtet, er sei in Britannien gewesen, Cæsar reports that he had been in Britain; Sokrates sagte, daß er nichts wisse, Socrates said that he knew nothing.

But (*a*) if the thought quoted should contain a judgment of the speaker, the indicative must be used, *e.g.* Er will nicht glauben, daß sein Bruder gestorben ist, He will not believe that his brother has died; and (*b*) if the verb is in the imperfect or pluperfect, the conditional mood (*i.e.* the imperfect of the subjunctive) is frequently used instead of the subjunctive, *e.g.* Ich fürchtete, er möchte fallen, I was afraid that he would fall; Er sagte, er wäre krank, He said he was ill.

(4) After verbs signifying to wish, to hope, to fear, to

pray, to command, to forbid, to allow, &c., referring to principal sentences, *e.g.* Ich hoffe, daß er kommen werde, I hope that he will come.

It is worthy of note that the subjunctive is always formed from the present tense of the indicative, *e.g.* Er gehe, he may go; er sei gegangen, he may have gone; er werde gehen, he will go; er habe geschlafen, he may have slept.

The conditional mood expresses a reality which is merely assumed by the speaker, *e.g.* Wärest Du aufrichtig, so glaubte man dir, und Alles stünde anders, If you were sincere they would believe you, and all would be different; Wäre ich nur zu Hause geblieben, Had I but remained at home.

In the inner chambers of the intellect thought is born. It is introduced into society by words. Similar ideas probably arise in every mind under similar circumstances, and yet the form in which these ideas may be expressed not only differ in different races and nations—Hebrew, Greek, Roman, French, German, or English—but even in distinct tribes and districts—England and Scotland, north or south of the Loire, Upper and Lower Germany, as the case may be. Hence we have languages and dialects. Besides this each individual has some specialty of nature which influences his mode of thought and manner of expression. In strong natures this is denominated *style.* Language is in this way a sort of Proteus undergoing continual outward change; but yet it remains for ever the servant of the sage. A general spirit lives and breathes in every language, and just as, in the natural world, every object, the more perfect its organization becomes, also becomes more marked and peculiar in its character, so in the intellectual world, as nations have particularized themselves and languages have been integrated and individualized, the more distinct and characteristic has speech, as it developed, become.

In every language there are two elements which demand the student's special care—(1) Words—the materials of speech, and the various significations they bear; and (2) forms—the inflexional changes and the syntactical relations on which the grammarian insists. The lexicon of Germany is fairly supplied with such words as designate the objects of experience, and it is unsurpassed in the power of representing in speech the internal life of man—the sentiments, feelings, intuitions, processes, and activities of the mind. In the subtle niceties and distinctions of social, political, or diplomatic life, it may not be so abundant as some other tongues; but in definiteness of phrase, depth of sense, and worth of words, it may compare with any. It is neither so light, so airy, so brilliant and sparkling as several in structure. Its syntax is organic—idea and word, as they spring forth from the mind, reveal their relationship by their connection. On that account German syntax constitutes rather a body of principles founded on reason, than a collection of rules to be retained in the memory.

In the course of our German lessons, which we now draw to a close, we have endeavoured to simplify and condense, and yet to omit nothing essential to a thorough mastery of the language. Knowing, as we do, the interest felt among all nations in the German people, and the literary products of their historians, philosophers, statesmen, novelists, scientists, and poets, recognizing the eagerness of many to acquire the means of holding personal converse with the best minds of that land of industrious thoughtfulness and assiduous study, and sympathizing with those on whom the necessities of life, business, travel, or health impress the desire to attain a solid acquaintance with German in its grammatical usages for wisely practical ends, we have strenuously endeavoured to present a full and accurate view, within the space at our disposal, of the inflexions and syntax, idioms and peculiarities of this excellent but difficult and disciplinary language. As an agent in intellectual training, a key to measureless wealth of instruction and delight, and an acquisition of almost unequalled utility to scholar, merchant, clerk, or artisan, German justly occupies a high place among modern languages. It combines more thoroughly than any other living speech the philosophic culture and the practical utility which the living interests of the day require in education. We earnestly hope that our plan of exposition and our mode of illustration have alike been found beneficial by the student. If any one has thoroughly devoted time and thought to the perusal and mastery of the lessons written for his learning, he ought now to feel himself able, with the judiciously employed aid of a good dictionary, to read ordinary books or magazines; at the same time, with persevering practice of the precepts set before him, the power of speaking will rapidly and certainly become his. Of the wide and rich territories, of which each earnest student may now enter into possession, we present a map-sketch in the historical outline of German literature given on page 1207.

For the purpose of keeping subjects technically distinct, the treatment of German handwriting, the explanation of the script character, and the directions for studying and acquiring it will be dealt with under PENMANSHIP (see page 1215). Turning to it, the student will find detailed directions for the prosecution of this very necessary accessory to the mastery and use of German, and an illustrative Plate, which will provide him with every facility for attaining the power of correspondence in this language. Presuming that the learner, following these instructions, has made himself an adept in the forms of German caligraphy, we recommend him now to revise all the exercises given him in this course in script hand, to copy out the reading lessons given, and to practise so thoroughly the art of German handwriting that German phrase and German form shall rise simultaneously in his mind, and the reproduction of any matter in German will be quite easy, whether in speech or writing.

ENGLISH GRAMMAR AND COMPOSITION.

CHAPTER XIII.

STRUCTURE OF SENTENCES—GRAMMATICAL AND RHETORICAL—STYLE AND SOME OF ITS LAWS.

SPEECH is the body of which thought is the soul. Correct thought is regulated by logical principles, and correct expression is governed by grammatical rules. They are two halves of an inseparable whole. Completely expressed, accurately developed thought is a vital organic result. It is a natural product capable of culture. Its results are sentences. Each sentence is (or at least ought to be) a whole, however numerous its parts may be. However brief or extended they may be, sentences ought to exhibit an entire unity of idea. Too many short sentences divide, break up, and weaken a composition. They make it difficult to keep the long succession of minute statements present in the mind and memory. Long sentences, in which many circumstances are introduced, reservations made, and slight distinctions insisted on, fatigue the attention and prevent the mind from seeing precisely what is really meant.

Short sentences are conversational, and long ones are oratorical. Composition to be good, ought to be as conversational and idiomatical as is consistent with the calm dignity and elevation which are expected in discourse. The clauses of a sentence should be so arranged that the whole may be easily and readily pronounced, and convey an agreeable impression to the ear:—(1) Clauses should neither be too long, nor disproportionately assorted; (2) they should be arranged in the order of their length and importance, *i.e.* form a climax—this, of course, supposes that the length of the clauses is to increase with the importance of the thought; (3) monosyllables ought as seldom as possible to end a clause, and terminational monosyllables ought never to be emphatic. In composing a paragraph, long, short, and intermediate sentences ought to be judiciously intermingled. Topics having little or no necessary connection with each other, or that are capable of being considered in separate sentences, ought seldom, if ever, to be discussed in one sentence.

Thought logically wrought out, should appear in its most definite form, and the sentence in which it is expressed should be capable of distinct apprehension. The arrangement of thought constitutes the main duty of the logician, the arrangement of expression is that of the grammarian or the rhetorician—of the grammarian if accuracy and consistency of phraseology are desired, of the rhetorician if appropriateness, efficiency, and attractiveness for the attainment

of any given purpose are required. Logic convinces, rhetoric persuades. Grammatical order suffices to give an idea *ex*pressiveness, rhetorical order is required to give it *im*pressiveness. Logic commends us to be particularly careful to acquire and possess a full and complete knowledge of the subject on which we intend to speak or write. Grammar advises us, while speaking or writing, in our choice of words to endeavour to unite reputable, national, and present usage in vocabulary and construction; and rhetoric requires—in order that fitness of phrases and speciality of effect may be secured—that we devote attention not only to select right words, but also to give each word in a sentence its due grammatical or rhetorical relation.

The structure of sentences, then, may be either (1) grammatical, or (2) rhetorical. The former is the order in which words are placed in ordinary and unimpassioned speaking or writing; the latter is the method of arranging words adopted when emotion and passion, as well as thought, require to be expressed and excited.

I. The chief laws relative to the position of words in *grammatical* structure are the following, viz.:—

(1) The subject *generally* precedes the verb; as,

"The shades of night were falling fast."

The subject may, however, be placed after the verb—(*a*) when the verb is intransitve, (*b*) when the sentence is interrogative or imperative, (*c*) when the sentence begins with here, there, thither, &c.; as,

(*a*) "Glanced many a light caïque along the foam,
Danced on the shore the daughters of the land,
No thought had man or maid of rest or home."—*Byron.*

(*b*) "Why rather, Sleep! ly'st thou in smoky cribs."—*Shakespeare.*
"Turn ye! turn ye! why will ye die?"—Ezek. xxxiii. 11.

(*c*) "Here leans the idle shepherd on his crook."—*Byron.*

"There were his young barbarians all at play,
There was their Dacian mother."—*Byron.*

(2) Articles are generally placed immediately before the noun whose signification they define; as, "Wisdom and truth, the offspring of the sky, are immortal; but cunning and deception, the meteors of the earth, after glittering for a moment, must pass away."

But when the noun is qualified by an adjective, the article precedes the adjective; the definite article (*the*) is, however, placed between the noun and the adjective *all;* the indefinite article (*a* or *an*) is put between the noun and the adjectives *many* and *such*, as well as between the noun and adjectives preceded by as, so, too, how, &c.; as, All the better sort attended; Many a one has read the story; Such a fate was terrifying.

(3) Adjectives are usually put before the nouns they qualify; as, The deep, blue sea

But adjectives follow nouns under the following conditions, viz. (*a*) when some circumstance depends upon the adjective, (*b*) when the adjective expresses dimension, (*c*) when it expresses the effect of a transitive verb, (*d*) occasionally when several adjectives belong to one noun, (*e*) when the adjective is employed as a title.

(*a*) "O maid! thou art so beauteous
That yon bright moon is rising all in haste
To gaze on thee."—*Milman.*

(*b*) A precipice three hundred feet in depth.

(*c*) "While Milton grew self-nourished in the shade,
Ten Wallers basked in day."—*Elliot.*

(*d*) A student, diligent, punctual, and obedient, will meet with respect.

(*e*) Alexander the Great was one of Aristotle's pupils.

(4) Adjectives often follow substantive verbs or past participles; as, The school which Thales' originated is called Ionic.

(5) Singular pronouns are placed inversely, *i.e.* the third precedes the second, and the second the first; plural pronouns take their natural order, and relatives follow their antecedent.

(6) Transitive verbs are generally placed before the words which they govern; as, The increase of wealth, the progress of knowledge, and the reformation of religion produced a great change.

(7) The infinitive mood follows the noun, adjective, or verb which governs it; as, My desire to effect his conversion was known; I am anxious to benefit those around me; Bacon tried to play a very difficult game in politics.

(8) Adverbs usually precede the adjectives, and succeed the verbs which they qualify; but if the verb have an auxiliary, the adverb may be placed between it and the verb; as, A very handsome offer; He discoursed effectively; I can readily enough accomplish that.

Adverbs sometimes follow the objects of active verbs; as He treated the people rather disdainfully.

(9) Prepositions, in general, immediately precede the words which they govern; as,

"Who taught you this?
I learned it out of women's faces."—*Shakespeare.*

(10) Conjunctions come between the words, phrases, or clauses which they connect; as,

"The beings of the mind are not of clay;
Essentially immortal, they create
And multiply in us a brighter ray
And more beloved existence."—*Byron.*

II. The chief law regarding *rhetorical* structure is, place the most important words and phrases in those positions in which they will acquire the greatest prominence and be most impressive. To effect this, the following among other variations of ordinary grammatical structure are allowable, viz.:—

(1) The subject may be placed after the verb; as,

"Within a windowed niche of that high hall
Sate Brunswick's fated chieftain."—*Byron.*

(2) Adjectives, if emphatic, may be placed first in the sentence; as,

"Brief, brave, and glorious was his young career."—*Byron.*

(3) Transitive verbs may succeed their predicates; as, That our elder writers, to Jeremy Taylor inclusive, quoted to excess, it would be the very blindness of partiality to deny.

(4) The infinitive may occasionally precede the verb which governs it; as, To labour is the inevitable destiny of man.

(5) Adverbs, when very important, may be placed at the beginning of a sentence; as,

"Softly tread the marge,
Lest from her midway perch thou scare the wren
That dips her bill in water."—*Bryant.*

(6) Conjunctions necessary in ordinary grammatical structure may sometimes be omitted; as,

"Admire, exult, despise, laugh, weep, for here
There is much matter for all feeling, man!
Thou pendulum between a smile and tear."—*Byron.*

(7) When we are desirous of sustaining the attention, exciting the curiosity, as well as giving weight to the sentiments expressed, the most important words may be employed to close the sentence; as, "When we attend to the infinite divisibility of matter; when we pursue animal life into those excessively small, and yet organized beings that escape the nicest inquisitions of the sense; when we push our discoveries yet downward, and consider those creatures so many degrees smaller yet, and the still diminishing scale of existence — in tracing which the imagination, as well as the sense, is lost—we become amazed and confounded at the wonders of minuteness, nor can we distinguish, in its effects, this extreme of littleness from the vast itself."—*Burke.*

William Ellery Channing, in his able and excellent lecture on self-culture, has said:—"Man was not made to shut up his mind in himself, but to give it voice, and enter into exchange with other minds. Our power of intellect lies not so much in the amount of thought within us, as in the power of bringing it out. A man of more than ordinary intellectual vigour may, for want of expression, be a cipher, without significance, in society; and not only does a man influence

others, but he greatly aids his own intellect, by giving distinct and forcible utterance to his thoughts. We understand ourselves better, our conceptions grow clearer, by the very effort to make them clear to another." The brilliant and eloquent G. L. Buffon declares that—"To write well is to think well, to feel well, to express well all at once; it is at the same time to exert mind, heart, and taste."

"Style," said the same master of literary expression, "is only the order and motion which we give to our thoughts. If we link them closely, if we compress them, the style becomes firm, nervous, and concise; if we allow them to follow each other negligently, and only connect them by the help of words, however elegant they may be, the style will be diffuse, slipshod, and insipid."

Ideas and words ought to be twin-born. But they can only be so when we understand words thoroughly, think correctly, and possess true knowledge. Ideas are the germs of sentences; but they assimilate the words of the vocabulary with which the thinker is familiar, as the flower-seed incorporates into its form the material of the soil, and assimilates into its fragrance the sunshine and the air. A wide and wise acquaintance with words and their uses is essential to the possession of a good style. It is never to be forgotten —(1) That words are the *representatives* of thought, and serve to call up into the mind the particular ideas of which they are the mental signs; (2) that there is no natural, necessary, and essential connection between these "signs and the things signified thereby;" (3) that at different periods different words are employed in the same language to symbolize the selfsame idea; and (4) that conventional agreement is that by which the peculiar signification of each term is adhibited to it and adstricted to it only. Hence a correct and elegant habit of composition requires (1) a complete and accurate knowledge of the language in which we (wish to) speak or write; (2) logical precision of thought; and (3) a clear perception of the purpose for which we (intend to) speak or write.

If style is the combined result of natural capacity and mental culture, it plainly follows that the general improvement of the intellect is the surest and safest method of attaining a sincere, healthy, pure, and natural style. He who desires to acquire an accurate, pleasing, and vivid style, may assure himself that extensive knowledge, sound judgment, precision of thought, clear perceptions, and delicacy of taste are the foundations of all excellence in speaking or writing; and that only by such means is a mode of diction gained

"Fit to be used by those who think while speaking."

Not beauty of language alone, minute accuracy in its use, fine thoughts, perfect syntax, the glow of feeling, or the vivid expressiveness of diction, "but the joint force and full result of all," constitute a good and pleasing style.

The supreme law of style is this:—Present each idea to the mind in such a way as to make the clearest and most lasting impression with the least demand for mental exertion on the part of the hearer or reader. Therefore (1) the idea to be expressed must be clearly formed and definite; (2) the words selected must be those which are most distinctly expressive; (3) these words require to be arranged in the best manner (for the writer's purpose), and (4) they ought to be harmoniously and attractively expressed. That is to say, in other words, each *idea* which we wish to express ought to be gradually unfolded, satisfactorily dealt with, carefully set forth, and each *sentence* ought to be free from anything that can retard, embarrass, or displease the intellect in its endeavours to comprehend it.

Style may, for convenience of treatment, be considered as divided into two parts—(1) *Diction:* Speak and write words according to the signification which strictly belongs to each; (2) *Structure:* Observe the relations which subsist among ideas, and represent these relations by such combinations of vocables, such variations in the inflexions of words, and such a use of particles as are customary in the writings of the best authors in that language.

The qualities of diction are—(1) Purity; (2) Simplicity; (3) Propriety; and (4) Precision.

(1) *Purity* is the employment of such words and phrases exclusively as, according to the best authorities, really belong to, and are part of, the particular language in which we speak or write.

(2) *Simplicity* consists in the use of such words and phrases as are most frequently and commonly employed, easily comprehended, and level to the capacities of the majority of the class for which what we write or speak is meant.

(3) *Propriety* is the employment of words in such a manner as to preserve the precise signification which "the best usage" has attached to each, and the careful discrimination of the nicer and more delicate shades of meaning which they acquire when used in peculiar collocations.

(4) *Precision* consists in giving exact expression to each particular thought in the most unambiguous manner, so as, in fact, to make misconception impossible. This is best done by employing the same words in the same rigidly-defined senses with unswerving uniformity and undeviating care.

Words taken singly have many significations. In composition, however, they lose their individual meaning, and form, by their syntactic junction, one special expression, indicative of the whole thought which is intended to be unfolded at the time. The words we use ought to be not only the distinct and transparent, but also the attractive and graceful medium of communicating our ideas. Nothing conduces more to the enlivening of expression than that all the words employed be as particular and determinate in their signification as will suit with the nature and scope of a discourse. The more general the terms used are, the fainter is the picture; the more special they are, it is the brighter and more attractive.

Words which are necessary to the sense, harmony, or beauty of a sentence ought never to be omitted; and *vice versâ*, words which are unnecessary to the sense or destructive of the harmony and beauty of a sentence should be elided or amended.

The using of the same word in the same sentence too frequently ought to be carefully avoided; especially avoid using the same word in different significations.

When expressions are in all other respects equal, those which are most harmonious and pleasing ought to be preferred. When of two words or phrases the one is univocal [*i.e.* permits of only one meaning] and the other is equivocal [*i.e.* capable of suggesting two meanings], the former should be chosen.

Unnecessary transitions from one person or subject to another, as well as ambiguity in the syntactical relations of words, ought sedulously to be guarded against.

There is a vital connection between language and thought. Unless we habituate our minds by arduous cultivation to acquire a right understanding of the proper meaning of words, to recall readily and to employ regularly the choicest and most select phraseology, we cannot expect them to be within reach on demand. To write well, not only the *matter* but the *medium* must be thoroughly understood.

The observations made, and the cautions given, may seem to be pedantic, minute, overstrainedly nice, and precise. That arises rather from the necessity of setting down each item with such distinctness that it may be understood and referred to when wanted, than from there being any disconnectedness or defect of unity in the principles on which the remarks depend. Professor William Duncan has most accurately pointed out the benefits derivable from carefully arranged and clearly defined, yet pertinent, distinctions. "The great art of knowledge," he says, "lies in managing with skill the capacity of the intellect, and in contriving such helps as, if they strengthen not the natural powers, may yet expose them to no unnecessary fatigue. When ideas become very complex, and, by the multiplicity of their parts, grow too unwieldy to be dealt with in the lump, we must ease the view of the mind by taking them to pieces, and setting before it the several portions separately one after another. By this leisurely survey we are enabled to take in the whole; and, if we can draw it into such an orderly combination as will naturally lead the attention, step by step, in any succeeding consideration of the same idea, we shall have it ever at command, and with a single glance of thought be able to run over all its parts."

GERMAN LITERATURE.—CHAPTER I.

FROM BISHOP ULPHILAS TO MARTIN LUTHER.

Germany has had a place in history for more than 2000 years. Its growth was slow; unfavourable circumstances impeded its internal progress, and surrounding conditions not unfrequently checked its outward development. Of the race which dwelt on the borders of the Danube and the Rhine, Greek and Roman authors give such accounts as show that they were men of warlike prowess and home-loving virtues. Songs—national for festive occasions, warlike for stimulating those who went to battle, or mourning for those who died upon the field; traditional, in which the folk-tales of the olden time were narrated; and domestic, in which the loves and joys of social life were celebrated—abounded even in a remote age among the Germans.

Ulphilas, bishop of the Mœso-Goths (Wallachians), by the invention of German characters, the translation of part of the Scriptures, and the employment of Christianity as an impulse to intellectual development, laid the basis of a vernacular literature among the Germans. Some writings on biblical subjects in the Mœso-Gothic tongue survive for the gratification of antiquaries, and some of the letters and homilies of St. Boniface (Winifred of Crediton, Devonshire, 714–754), archbishop of Mayence, and "the apostle of Germany," who died a martyr among the Frisian pagans, remain to show that zeal and learning were both used to animate the heart of the people of Central Germany.

From the days when Charlemagne—having formed his court into a sort of learned academy, of which he was "the sweetest David," and Yorkshire Alcuin (who died in 805) was the Horace of the Emperor of the West—took the culture of the German language under his patronage, and even, it is asserted, wrote a grammar of it, collected the old Teutonic laws and the antique songs of the Alemannic races, literature began a new career of progress and improvement.

A Christian poem, called *Muspilli*, describes in sublime alliterative verse "The End of the World and the Judgment;" next to this may be noted a History of the Life of Christ, a harmony of the Gospel narrative, written by desire of Charlemagne's son, Ludwig der Fromme (Louis le Debonnaire). It bears the title of *Heliand* (the Saviour). It is regarded in Germany as a matchlessly majestic religious epic. Its *Liedstäbe* (song-staves) are finely alliterative. Thirty years thereafter, under Ludwig der Deutsche, Otfrid, a Benedictine of Wissembourg, in Alsace, composed a new harmony of the Gospels in verse, no longer emphasized by accent and alliteration, but rounded off into rhyme. This new style became the fashion, and the Ludwigslied, in celebration of the triumph of Louis the Fat over the Normans in 881, was written in the measure which afterwards became popular among the minnesingers.

Though occasionally a burst of song, evoked by some heroic achievement or interesting episode—*e.g.* the pæan on the defeat of Eberhard by Henry of Saxony at Eresburg (912), the odes on Adelbert of Babenberg and on Conrad the Short, the song on the Hunting of the Urus by Duke Erbo of Bavaria, and those which greeted Henry III'.s successes in the Hungarian wars, brought to a close by the peace of Stuhlweissen (1044)—rose like a dream-snatch in the sleep of two centuries and a half, yet the poetic style of Otfrid, when the genius of Germany was suddenly aroused by the sunrise of the East in the crusading times, reappeared with power and beauty in *das Blüthenalter*.

This splendid period may be dated from the accession (1138) of Conrad III. of Franconia, in whose reign the wars of the Guelphs and Ghibellines began, and the poetic incident of Weinsberg (1140) occurred. Those days of daring deeds and of the poetry of noble life gave origin to the *Heldenbuch* (Book of Heroes), which embalmed the heroic legends of the German race, rehearsing the vital oral traditions which the *Bänkelsänger* (ballad-singers) had carried in their memories since the days when Attila fought in the Rhine-country for the civilization of the West against the aggression of the East. It, as the *Nibelungenlied*, commences by reminding us—

"Uns is in alten Mären Wunders viel geseit
Von helden lobe baerem, von grosser chuoneit,
Von vrouden und hoch geziten, von weinen und von chlagen,
Von chuner rechenstritten, Muget ir un wunder hören sagen."

("To us there is in antique story wonders many told
Of heroes great in glory, of spirits free and bold,
Of joyousness and high-mirth, of weeping and of wail,
Of strife of men of war-worth, mote ye hear the wondrous
tale.")

That after-ages might be able to hear these stories Wolfram von Eschenbach, Heinrich von Ofterdinger, Walther von der Vogelweide, and others, brought into one book the romantic and poetical chronicles of the courageous, *e.g. Der Kleine Rosengarte* of Kriemhilda at Worms; *Der gehörnte* (horny) *Siegfried*; the delicately-toned story of *Gudrun*, daughter of Hettel and Hilda, the betrothed of Herwig, king of Seeland, &c. For the preservation of this intrinsically valuable series of mediæval poems, as well as the *Nibelungenlied*, *Eric and Iwein*, &c., we are indebted to Maximilian I., who caused them to be transcribed and placed in a Tyrolese library. The Nibelungen was an ancient (mythical) royal race possessed of immense (though fatal) treasures, in relation to which the semi-historic folk-lore of the olden times, the lives, loves, feuds, intrigues, passions, fights, murders, and deaths of the popular personages of tradition—*e.g.* Siegfried and Brunhilda, Gunther and Kriemhilda (Siegfried's wife), Haco of Norway, Dietreich (Theodore) of Berne, Etzel (Attila) the Hun—are detailed in the finest style of epic poetry. [For an excellent analysis of this poem the reader may be referred to Carlyle's *Miscellanies*, vol. iii., and to Chambers' *Repository of Tracts*, No. 96.]

The *Minnelieder*, the music of the heart-dreams of some past-remembered love, were the outgush of romance and affection, and were unwritten, except in the red-leaved volume of the heart, for fully a century. The strict metrical form which prevailed in them shows that they were designed for being easily remembered. Take for example Walther von der Vogelweide's

Lob der Frauen

(PRAISE OF WOMEN).

"Durchsüsset und geblümet sind die reinen Frauen;
Es gab niemals so wonnigliches anzuschauen
In Luften noch auf Erden, noch in allengrünen Auen;
Lilien und der Rosen Blumen, wo die leuchten
Im Maienthaue durch das Gras, und Kleiner Vögelsang
Sind gegen diese Wonne ohne Farb und Klang
So man sieht schöne Frauen,
Das Kann den trüben Mut erquicken
Und löscher alles Trauern an derselben Stund,
Wenn lieblich, lacht in Lieb ihr Süsser rother Mund
Und Pfeil' aus Spiel' uden Augen Schiessen nis Mannes
Herzens Grund."

("In sweetness and fresh bloom pure women are enfolden,
Ah, never was there aught so winning-like beholden,
In the sky, or on the earth, or in the meadows golden!
Even the light white lilies and the rose-buds bright that
gleam
In the May-dews of the grass, and the little bird's soft lay,
As compared with this delight, in hue and sound too, fade
away.
If fair women are beholden,
Joy from out sad gloom of heart may beam,
And sadness vanish quite even in that selfsame hour,
When pleasant smiles of love on sweet red lips have power,
And shafts from gleesome eyes, flash to man's heart of
hearts their piercing shower.")

Perhaps the most popular of the knightly (Herren) singers of those memorial lyrics was Heinrich von Meissen, a strolling minstrel, who so won the praise of women as to be called *Frauenlob*. On his death at Mainz, in 1318, weeping women carried him to his grave and poured so much wine on his tomb that the floor of the church was overrun by it.

The Minnegesang were principally the productions of men of knightly rank, but *Bardenlieder* were also composed by

the burgher (*meister*) class. They formed poetical clubs or guilds, and thus the *Meistergesang* arose. Frauenlob is regarded as the suggester of these associations of musical tradesmen in such places as Mainz, Augsburg, Nuremberg, Colmar, Ulm, &c., which met on Sundays and holidays to compete in rhyme before a president (*Gemerk*), a treasurer (*Büchsenmeister*), manager (*Schlüsselmeister*), chairman of adjudicators (*Merkmeister*), and wreath-keeper (*Kronmeister*). The songs required to be neat, orderly, tradesmanlike, and the rules of their art (*Tabulatur*) were very precise. Of these Hans Sachs the Nuremberg cobbler, has acquired the greatest reputation. He was fertile-brained, lively, humorous, and popular. He told good stories, composed numerous [208] dramas, and versified many portions of the Scriptures. His poems of different sorts, it is said, amounted to 4200 during a poetic career of fifty-five years. He died brain-worn but cheerful, 25th June, 1576, aged eighty-one. His *Schlaraffenland* (Lazybonesland, the Sluggard's Paradise) is highly amusing and satirical; and his *Der faule Bauernknecht* (the Slothful Peasant) is biting, and yet told with hearty naturalness.

The *Volkslieder*, or national ballad poetry of Germany, is rich and valuable. It seldom happens, however, that the names of ballad-authors in the earlier eras survive their own day. Simplicity of style, emotional incident, lyric liveliness, truth of feeling, and heartiness of sentiment, generally characterize them; they were produced by, and for the people; expressed their hopes, joys, fears, experiences, and aspirations, and hence their extensive popularity and takingness. The familiar lyrists of these times were divided into two classes—*geistliche* and *weltliche Liederdichter*, according as hymns or ballads were their forte. Of the *weltliche* sort Sachs was the most amusing and excellent. Among the *geistliche Liederdichter*, to whom the masterly perfection of German hymns and psalms are due, Johann Mathesius, Johann Arndt, Martin Luther, &c., are highly distinguished. The stirring melodies which the great German reformer composed for the religious culture and elevation of the people are among the most precious treasures of the spiritual songs of any age or nation.

Luther (1483–1546) must be regarded not only as the reformer of religion, but as the reformer of the German language. Towards the refining and perfecting of the Teutonic tongue, imparting harmony of tone and beauty of diction, and bestowing upon it classical correctness combined with force and elegance, nothing has contributed so much as his translation of the entire Bible into the pregnant speech of the fatherland. In it idiomatic freedom and familiarity of phrase are felicitously balanced by careful grammatical inflexions and reasonable syntactic sequences, while the singular translucency with which the original scripture story shines through the language of the mid-European nationalities, supplies a favourable model of verisimilitude in translation. Amid the passionate stress and intellectual strain of his wondrous life, Luther's supremacy of influential thought and social power was felt from peasant's hut to papal throne. He gave distinct shape and utterance to the aims of his age. His words, though vernacular, are not vulgar. He formulated into aphorisms the opinions of his fellows. His resolves became the laws of princes, and his polemics governed the diplomacy of the world. The German literature of his time everywhere bears the mark of Luther's personality. Jacob Grimm says of him in this aspect—"The language of Luther, on account of its noble and almost wonderful purity, and the powerful influence it had upon his followers, may be regarded as the basis of our modern high German." Nothwithstanding the bitterness, license, and even coarseness of much that was said and done by him, he carried a healthy manliness with him through the world, and hence Dr. Martin Luther has become typical of the many-minded German race. We owe to him the typical hymn, *Ein Feste Burg ist unser Gott*, written at Coburg, in 1530, during the holding of the Diet of Augsburg, and sung not only at that Diet but in all the churches of Saxony.

Great and learned men surrounded Luther, and they also aided in quickening the power of the language of their age. The distinguished patriot Ulrich von Hutten (1488–1523), the associate of scholars and poets, and himself justly entitled to be ranked among such men, did much to prepare for and promote the Reformation. Though he was a master in Latin composition, he resolved, when he allied himself with Luther, to write in the language of the fatherland.

John Reuchlin (1455–1522), who in Cardinal Fisher's opinion, "bore off from all men the palm of knowledge in all that relates to religion and philosophy"—the "eruditorum alpha" of his age, an Oriental scholar without a rival, was a colleague of Luther's at Wittemberg. He and Erasmus were the two "eyes of Germany;" Cologne was to put out the one, Louvain the other. The light of neither was blotted out. Though neither of these great scholars actually separated themselves from the Romish communion, yet Luther acknowledged that he only followed Reuchlin's steps in carrying out the Reformation. Pfefferkorn's *Handspiegel* and Reuchlin's *Augenspiegel* are only tracts, but they show the keenness of the assault made on learning by the Cologne obscurantist, and the clearness of the scholarship the student of Pforzheim brought to bear upon the question. Then a shower of squibs flashed forth, and religion and learning triumphed with Reuchlin. Helius Eobanus (*Hessus*) the poet of the Reformation, whom Erasmus regarded as the Ovid, and Camerarius as the Homer of Germany, was a lyric and elegiac bard unapproached during his lifetime in Germany. His version of the Psalms took the heart of the Teutons at once, and Luther regarded them as incomparable. He was an authority on all matters of *Belles Lettres*, but his irregular habits led him into many difficulties. Philip Melanchthon (*Schwarzerde*) learned from Bebel to write Latin with the ease and fullness of a Roman, and by his gentle persuasiveness gained many advocates for the reformed opinions, while by his scholarly power he kept the controversies on religion within fair bounds. To the Latin folios of theology Johann Bugenhagen added; like Melanchthon, however, he also aided Luther in his translation of the Scriptures. Œcolompadius, David Paræus, Heinrich Bullinger, Xylander, Buxtorf, Taubmann, Agrippa, Zwinglius, and Servetus, are all Latin writers. Conrad Gesner was the "Pliny of Germany." It was also at this period, 1525, that the earliest German grammar made its appearance, and in 1530 Luther issued "A Series of Fables," by Æsop, translated into German—"an amusing and profitable work," as he says, "for every man, whatever may be his station."

A considerable period of mental lethargy followed the Reformation, and the wars of that time spread such wretchedness and misery over the land that intellect seemed almost blighted. But near the close of the sixteenth century, the mystic shoemaker of Goerlitz, Jacob Boehme (1575–1624) appeared, and taking the vernacular as his medium for teaching his theosophy, sent abroad in the "Aurora" his proposed solutions of the dark problems on which so much dogmatic strife has been elicited, concerning original sin, the causes of evil, the freedom of the will, &c. The earlier Quakers took much of their system from this work. In his "Mysterium Magnum," the author states that in intellectual vision he saw how plants, trees, stones, metals, and living creatures were originally formed, and many "unutterable things," which Dr. Johnson thought he should have left unuttered. Caspar Schwenckfeld of Ossing (1490–1561), had previously attempted the spiritualization of Lutheranism. To Johann Kepler (1571–1630), a contemporary of Boehme's, we owe many discoveries in optics, physics, geometry, and astronomy—especially of those three laws of planetary motion which bear his name. See Astronomy, page 252.

Johann Fischart of Mainz is a sort of rough compound of Aristophanes, Rabelais, and Swift, with a dash of Sterne. His eccentricity of style exceeds the verbal legerdemain of the author of "The Clouds." The French canon, the Irish dean, and the Yorkshire parson (Yorick) are quite outdone by him. In graphic description he is not excelled by any (one might say all) of them. His uncouth words and far-fetched compounds, in a German adaptation of Garagantua and Pantagruel (1552), are more tantalizing even than his humorous original, and he runs riot in his satire against almanac-makers. In *Der Bienenkorb* he lashes other follies of his day, and even yet the boat-excursion of the Gunsmiths' Club of Zürich, as related in *Das glück-*

haft Schiff von Zurich may make the dullest smile. *Der Froschmäusler*, by Georg Rollenhagen (1542-1609), *Der Ganskönig*, by Fuchs, *Wendunmut*, by Kirchkoff, and *Das buch von den Schildburgen*, are all comical and satirical. Georg Wickram's "Traveller's Handbook, containing many pleasant Jokes and Stories," has all the characteristics of the coarse amusing chapbooks, of which it was a most popular specimen. Jacob Ayrer was a younger contemporary of Hans Sachs, next to whom he was the most productive dramatist of Germany. He was a doctor of law, notary and advocate of Nuremberg, who put stories into dialogue for his own amusement. Duke Henry Julius of Brunswick (1563-1613), also wrote several comedies for the stage of his own court, following in them the English model which he had seen while visiting his brother-in-law, James I., in the days of Chapman, Jonson, and Shakespeare.

GEOLOGY.—CHAPTER XIII.

THE CRETACEOUS SYSTEM—THE CHALK SERIES—GREENSANDS—GAULT—FLUVIATILE AND MARINE FORMATIONS—WEALDEN CLAY—SPEETON CLAY—FLORA, FAUNA, AND SCENERY OF THE PERIOD.

NEARLY one-eighth part of the geological crust of the earth consists of carbonate of lime. Chalk is carbonate of lime composed of a white, brilliant metal called *calcium*, combined with oxygen and carbonic acid. Carbonate of lime, however, is not always chalk. The crystalline mineral named *calcite*, and those compact polishable limestone rocks classed as marble, are carbonate of lime, possess the same chemical composition as chalk, yet have no resemblance to it. Lime forms the basis of a considerable number of minerals, beautiful in structure and useful in the arts. All limestones owe their origin to organized substances. The student will find it interesting to compare the four typical specimens (figured in Plate IV., 7, 8, 9, and 12) of Speeton chalk, forest marble, magnesium limestone, and Carrara marble. Chalk is usually pure white and friable, though the Norfolk chalk is red, and the Antrim chalk, owing to the overlying basalt, is hard and indurated. To the naked eye it appears much more uniform in texture than sandstone or granite, and yet it is really much more various in the forms of its component parts, like in colour and composition though they are. It consists of minute shells, pieces of coral and of sponges, and of white particles, which are indeed the remains of comminuted (broken-down) shells. Often, embedded in chalk formations, large well-preserved shells, sea-urchins, and mouldered fragments of other creatures of the sea, present themselves to investigators. The student will do well here to compare the irregularly interfused crystalline forms of granite (Plate IV., fig. 4) with the sedimentary cretaceous deposits to which we have already referred; or better still, procure a piece of granite, of sandstone, and of chalk, and examine each of them thoroughly as specimens of the great type-groups of crystalline, granular, and organic deposits—deposits not only containing organic remains in them, but made up entirely of them.

As in England and the west of Europe a thick band of white chalk (Lat. *creta*) forms one of the most important of the geological formations found lying above the strata of the Jurassic period, the third division of the Mesozoic era has received the name of the *Cretaceous* system. It is not, however, to be hastily inferred from the name given to this group of rocks that chalk is the exclusive formation in the strata it includes. Sandstone predominates in North America, Saxony, and Bohemia; coal occurs in North Germany and the Gossau beds of the Alps; and shales and ironstone in the Canterbury seams of New Zealand. Of this system there are two types: (1) a fluviatile or estuarine delta-like formation, that of the Weald of Sussex and Kent in the south of England; and (2) a marine formation, which from its being well developed at Neufchâtel (Neocomium), in the west of Switzerland, is called *Neocomian*. The Wealden delta, notwithstanding the denudation to which it has been subjected, and its being overlaid with Eocene strata, which rest conformably upon it, extends east and west 200 and north and south 100 miles, and therefore covers an area of 20,000 square miles. The bed of the German Ocean seems to be cretaceous, and so to connect the groups of South-east Britain with those of the north of France, of Germany, and of Denmark, which cover a large extent of Europe and of Eastern Asia. While the fluviatile and estuarine deposits of the Wealden were being laid down there appears to have been accumulating in neighbouring areas thick cretaceous marine deposits, which are represented in the Speeton clay, as seen exposed at Filey Bay, Yorkshire. This passes down into the Jurassic system, and rests upon Portland strata, below which Kimmeridge clay is found. It is the British equivalent of the continental Neocomian strata. A pretty definite geological distinction obtains between the upper and lower formations of the Cretaceous system, the mark being characterized by a break in the palæontological fossils and clear traces of unconformability. The *creta* of this system is a white, soft, pulverulent limestone, formed almost wholly of carbonate of lime, non-chemical, a precipitate of the minute shells of Foraminifera and disintegrated fragments of larger ones—Pinna, Cytherina, and some of the Estromaceæ—together with some of the silicious frustules of the Diatomaceæ, and the spicules of sponges, which have aggregated into flint. Covering so large an area as it does—for while constituting one of the most important European formations, it occupies large areas in North America, Northern Africa, Asia, and Australia—it differs greatly in lithological character, and the palæontology of the Cretaceous series suggests many embarrassing considerations. On the whole the following classification, which we arrange in descending but describe in ascending order, seems to be distinct and conformable to observed types:—

The Cretaceous Series (as they occur in Britain).

I. The Upper Cretaceous System.

1. Chalk, . .	(1) Maestricht or Norfolk chalk. (2) Upper (flinty) chalk. (3) Lower (flintless) chalk. (4) Gray chalk marl. (5) Chloritic marl.
2. Upper Greensand, .	Greenish-gray sandstones and sands.
3. Gault, . .	Stiff blue clay, with calcareous and pyritic nodules.

II. The Lower Cretaceous or Neocomian System.

FLUVIATILE.	MARINE.
1. Wealden clay. 2. Hastings sands:— Tunbridge Wells sands. Wadhurst clay. Ashdown sands. Ashburnham beds.	1. Lower Greensand, { Folkestone beds. Sandgate " Hythe " Atherfield clay. 2. Upper part of Speeton clay. 3. Pinnfield and Tealby beds. Middle part of Speeton clay. Lower part of Speeton clay.

Hastings Sands consist of a great series of shale and sandstone, with beds of lime and ironstone. Out of the white sandstone of this period the picturesque rock scenery around Tunbridge Wells has been wrought by weathering. In the immense valleys which have been furrowed through these cretaceous formations the prodigious extinct Reptilia, by discovering which Dr. Mantell won fame, are found.

Wealden Clay, fresh-water strata, consisting of blue and brown clay and shale, with intervening sandstone beds and limestone, often containing in great abundance the remains of flora and fauna, *e.g.* ferns, cycads, and conifers; and besides many turtles, the Iguanodon, Hylæosaurus, and Pterodactyl. Analogues of the Hastings sands and Wealden clay are found in North-west Germany, and yield abundant remains of land-plants, which sometimes form thin beds of a bright black coal.

The dark clayey deposits of *Speeton*, which are well displayed where the chalk cliffs of Flamborough Head rise up from the sea, yield reptiles' bones, and their numerous marine fossils, ammonites, brachiopods, cephalopods, &c., are found to correspond with those of the Lower Cretaceous

series of the Continent. The lower, central, and upper divisions contain differentiating fossils, *e.g.* the first shows *Ammonites noricus*, the second *Pecten cinctus*, and the last *Perna mulletti*. Above these range, in order, the Atherfield clays and the Hythe, Sandgate, and Folkestone beds of marl or clay. In these, vegetable fossils are rare. Ctenoid (perch-like) and Cycloid (salmon-like) fishes appear in these groups, though Placoids and Ganoids still continue numerous.

The *Lower Greensand* is a marine deposit reposing on Wealden strata. It shows that the sea was gaining on the land. It was formerly known as iron-sand from its being cemented by oxide of iron. Sand prevails in the upper layers and clay in the lower. Both are more or less indurated, and calcareous beds occur. The limestone usually known as "Kentish rag" is a highly fossiliferous stone of this formation. Some of its clay-beds are used as Fuller's earth. Fossil marine remains, especially Mollusca, abound in its bands.

Gault is a stiff, compact, blue clay containing calcareous and pyritous nodules. The upper part is hard and sandy, having green specks of silicate of iron in it, and the lower part is a plastic, tenacious, dark clay, uniform in its texture and useful for tiles, bricks, &c. It intervenes between the Lower and Upper Greensand. The fossils in it, ammonites, scaphites, turrelites, and cephalopodous molluscs, are beautifully preserved. Surrey gault is considerably phosphatic, and probably the Blackdown beds of Dorset are littoral deposits contemporaneous with the deep-sea gault.

Upper Greensand is a group of sands and sandstone overlying the gault. They receive their specific designation from the presence of grains of glauconite (a hydrous silicate of iron and potash), which, filling the shells of rhizopods, and forming casts or enveloping the grains of Foraminifera, impart a sea-green tint and sometimes a glistening lustre to their masses. It is a silicious or calcareous sand, with beds and masses of concretionary grit, known as (Merstham) firestone. At the base of the Cambridge chalk a deposit is worked for its phosphates of lime, derived from the bones and "coprolites" of Reptilia. In it are also found the remains of Natatores, birds allied to our extant gulls. Greensand strata extend from the cliffs of Kent eastwards into Devonshire, and are well exhibited in the cliffs of the Isle of Wight. Geologists think that these greensands are littoral deposits made on the shores of the Cretaceous seas; that while the chalk was being laid down in the sea-beds these were contemporaneously deposited on the shore; that, as the sea widened its area, the chalk covered and submerged the sand. Sponges, molluscs, sea-lilies, star-fish, sea-urchins, lobsters, &c., abound in these formations; while Polyzoa, in their marvellous colonies of industrial life-groups, wove their curious sea-mats in their varied cells.

Chalk, the member of the Cretaceous system from which it derives its designation, overlies the greenstone, and in its early deposits partakes somewhat of its character in being glaucous, pyritic, and phosphatic. It is subdivided into—(1) Chloritic marl, a marl of white or yellowish base with green (chloritic or glaucous) grains in it; (2) Chalk marl, an argillaceous marl holding varying quantities of clay and sand—sometimes phosphatic; (3) Lower (flintless) chalk; (4) Upper (flinty) chalk; and (5) Maestricht or Norfolk chalk. The upper chalk consists of pure white friable limestone, too soft in general for a building stone, and yet sometimes found capable of being used for building purposes. It contains many bands of interstratified flints and vertical masses called "potstones." Iron pyrites occur in radiated nodules in these beds. It is what geologists call "meagre" to the touch, soils the fingers, and crumbles easily. It consists mainly of shells and débris of shells. The lower chalk is of the same character, except that it wants the flint. Maestricht chalk rests unconformably on the upper chalk. It is a soft, yellowish, pisolitic, and calcareous formation, and contains such an admixture of cretaceous and tertiary fossils that several geologists incline to regard it as holding an intermediate place between the Mesozoic and the Cainozoic ages. Considerable differences of opinion have been expressed concerning the upper limits of the cretaceous series, some holding that the period of lignific trees should be regarded as tertiary, and others that the lignific series are —from the cretaceous shells they contain—rightly included in the chalk deposits.

Prior to the Cretaceous period two classes of plants prevailed —(1) cellular cryptogams, and (2) dicotyledonous gymnosperms, but in this a third class makes its approach—dicotyledonous angiosperms. Arborescent ferns still abounded; conifers gathered together in great forests. Among the woodlands may be recognized plant-types which approximate closely to those which now exist. The maple, the alder, the walnut, the wych, elm, &c., send their forerunners, and the palms differ little from those which now adorn our tropical climes. The triple-veined leaved Crednaria, whose place in botanical classification has not been determined, made its advent and flourished in eight species.

The colossal types of crocodile, lizard, and turtle of the Oolitic formations are disappearing. A few Plesiosauri and Ichthyosauri still drag their huge bulk through the shallow oceans. The iguanodon crawls among the brushwood and herbage, and the dragonish-formed pterodactyl never appeared on earth again after the Cretaceous period closed. The earth was probably too much subject to inundations, earthquakes, storms, irregularities of temperature, and not very well fitted for occupation by any higher order of animals than those huge Saurian reptiles. But they—marine, amphibious, and terrestrial—weltered in the seas, haunted the estuarine margins, or ranged the jungles of this era. Molluscs, though fewer in genera, were far more curiously formed. Lovely shell-fish, exquisitely minute, delicate in spire and whorl, occupied the water-world. Both herbivorous and carnivorous creatures were active and numerous. The ideal solitudes of the Cretaceous forests were full of abundant vegetation. The marsupials, akin to the kangaroo, sported among them, and those gigantic Saurians, like the mososaurus of Maestricht, in Belgium, wandered over their pathless "contiguities." But even fancy cannot realize the animal life of its seas, the multitude of the living forms that swarmed in them, and the seaweeds, which lent their charm to the shores of the far-extending oceans.

The reader may, perhaps, form an idea of the probable scenery of the period from a verbal description, aided by a comparison with some of the well-known characteristics of tropical landscapes at the present day. He can imagine the sunlight playing upon the quaint, vigorous foliage of the pillared trees, and tipping with golden hues the feathery fronds of the flexile ferns. In the passing wind tall palms, in the distance, wave their fan-shaped leaves, which ever and anon droop like the plumes of a knight's crest in the rush of battle. Rich grasses and exquisite mosses clothe the living sward, and the murmur of insects fills the air. Their monotonous hum is occasionally interrupted by the crash of an aged tree in a distant forest glade, or the curious cry of some listless, lizard-like reptile, or the hoarse roar of the iguanodon and the megalosaurus, as they engage in furious combat. These huge monsters contend for supremacy amid scenes where their mighty bulks bring fear; but far away the walnut, the maple, and the alder rear their well-known trunks in still and shadowy avenues. Vegetation is at once temperate and tropical, and the temperature, while fresh, is also genial, admirably adapted to the growth of the more vigorous forms of vegetable life.

In order that the student may the better comprehend the relations subsisting among the whole series of formations—(1) Triassic, (2) Jurassic, and (3) Cretaceous—comprised in the Mesozoic strata, we have endeavoured in the four diagrams on Plate VII. to illustrate (1) the relative positions of the coal measures and the magnesian limestones of the Carboniferous and Permian periods of the Palæozoic era and the Mesozoic formations. These latter are next shown in their relations one towards another through the Triassic beds to the Lias of the Jurassic era, as explained in pp. 1108–10. This is done in fig. 1. Fig. 2 shows (1) the relation between the Liassic and Oolitic rocks in Oxfordshire, and so illustrates what has been said of them at pp. 1110–13; and (2) exhibits the course of the geologic formations through the Mesozoic era, from the Rhætic Trias to the Portland beds of the Jurassic system, with the Wealden of Shotover over-

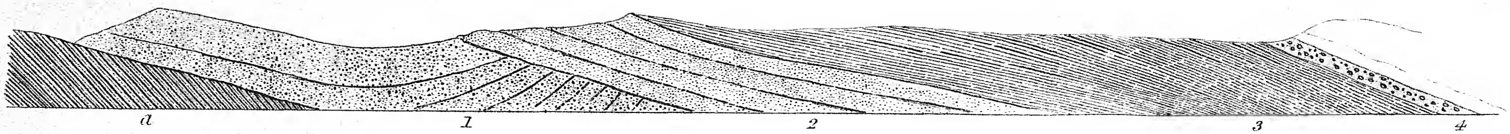


Fig. 1. 23 Diagram of Permian, Triassic, and Rhætic formations in Britain.

a Coal Measures, 1 Permian Sandstone, Marl, and Conglomerate. 2 Triassic Sandstone (Bunter) 3 Triassic Marls (Keuper) 4 Rhætic Beds, b Lias.

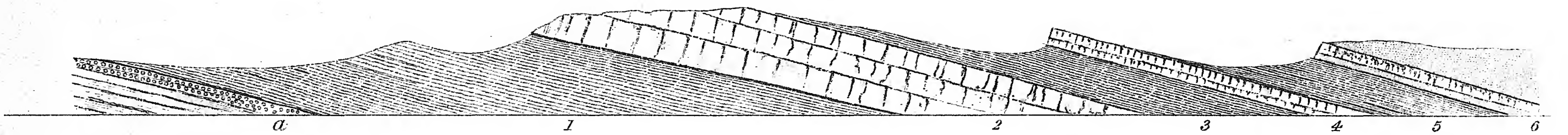


Fig. 2. 24. Diagram of Liassic and Oolitic Rocks in Oxfordshire.

a Rhætic, 1 Lias, 2 Lower Oolites, 3 Kelloway Rock and Oxford Clay, 4 Coralline Oolite, 5 Kimmeridge Clay, 6 Portland Sands and Stone. b Wealden of Shotover.

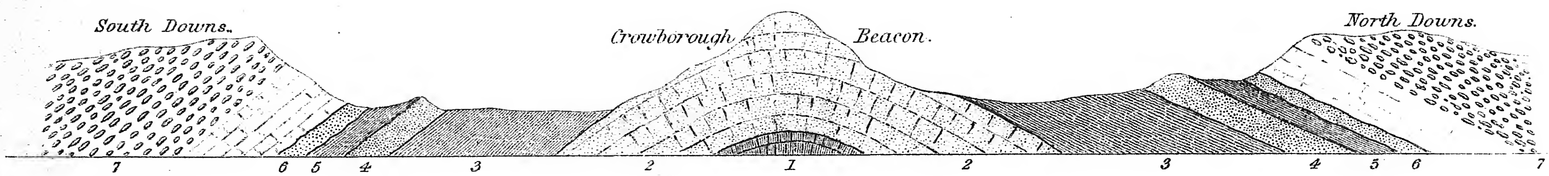


Fig. 3. 25. Diagram through Wealden area of Kent and Sussex.

1 Purbeck Beds, 2 Hastings Sands, 3 Weald Clay, 4 Lower Greensand (Neocomian) 5 Gault, 6 Sandy Chalk-Marl, 7 Chalk.

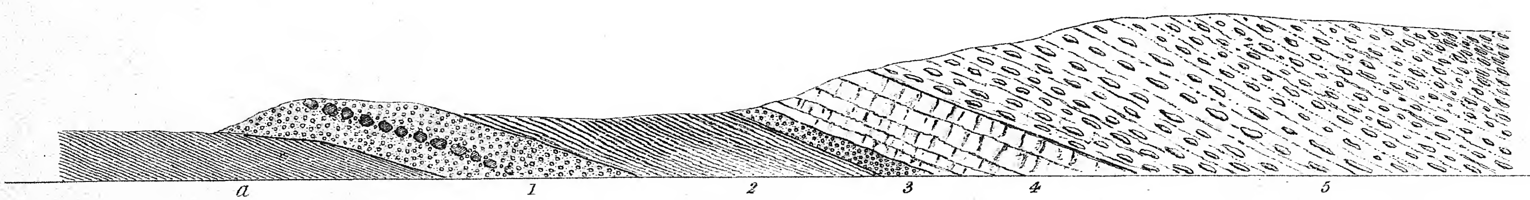


Fig. 4. 26. Diagram of Cretaceous Rocks in Cambridgeshire.

a Kimmeridge Clay, 1 Lower Greensand, 2 Gault, 3 Chloritic Marl, 4 Lower Chalk, 5 Upper Chalk.

lying them. In fig. 3 we have an ideal arrangement of a section of the Wealden strata of freshwater sands and clays, forming, with the Purbeck beds below them, the deposits of the era of change from the Jurassic to the Cretaceous period, and presenting in their order the rocks which we have just been describing, as they are found in Kent and Sussex, so far as they reach; and in fig. 4 the student is shown how, in Cambridgeshire, the lower greensand overlies the Kimmeridge clay of the Upper Oolitic series, and the other members of the Cretaceous formation take their places in due order thereafter. In this way the several diagrams help us to map out in our minds the succession of the strata of the Mesozoic period, and give to the memory some holdfasts of the names and relations of the several formations which are comprised in it.

ALGEBRA.—CHAPTER XII.

SIMPLE EQUATIONS CONTAINING MORE THAN ONE UNKNOWN QUANTITY.

SUPPOSE that there is brought before us simultaneously two such equations as the following—$x+y=15$ and $x-y=7$, in which we have (1) two unknown quantities, x and y, and (2) two independent conditions expressed regarding them. It is obvious that no single condition of either of these equations is sufficient to fix the value of the quantities. Each condition connects them, nevertheless, in such a way that if one can be found the other can be also known. Taken separately, the equations are therefore indeterminate [*i.e.* they admit of an indefinite number of solutions], for the first will manifestly be satisfied by any pair of numbers whose sum is 15, and the second by any pair of numbers whose difference is 7. The following are instances of possible solutions:—

Solutions of the First.		Solutions of the Second.	
$x=12$	$y=3$	$x=12$	$y=5$
$x=11\frac{1}{2}$	$y=3\frac{1}{2}$	$x=11\frac{1}{2}$	$y=4\frac{1}{2}$
$x=11$	$y=4$	$x=11$	$y=4$
$x=10\frac{1}{4}$	$y=4\frac{3}{4}$	$x=10\frac{3}{4}$	$y=3\frac{3}{4}$

and so on for as many pairs of numbers as we please. But the real solution required here consists in finding a set of values for x and y which shall simultaneously satisfy both equations. Such a solution is contained among the preceding instances, where we find a set of values, $x=11$ and $y=4$, which satisfies both the given equations at once.

A group of equations of this sort, in which we have the same number of equations and unknown quantities, is called a *system of simultaneous equations;* and the first part of the process of solution consists in eliminating one of the unknown quantities [*i.e.* by some combination of the two equations to derive a new equation from which one of the unknown quantities shall be excluded].

We shall exemplify and explain a case which may aid the student to understand our remarks on the processes employed somewhat better than if we proceeded to state the matter in a merely abstract form.

PROBLEM.—Find two numbers such that four times the former added to three times the latter give 26 as their result, while seven times the former with eight times the latter subtracted from it will leave 19 of a remainder.

Let x represent the former and y the latter number, and we have these two equations: (1) $4x+3y=26$, and (2) $7x-8y=19$, which show that the values of x and y (unknown) are the same in each.

In proceeding to resolve these two equations [*i.e.* to find the respective values of x and y in each and both] we must use some method of elimination, so as to dissociate provisionally the one from the other, and have to treat the question as if it were but an equation with one unknown quantity. This may be done by (1) substitution, (2) comparison, or (3) reduction. (1) In the first method we take the value of x, which is $x=\frac{26-3y}{4}$, and substituting that in the equation for the resolution of y, we have the following state of the question—$7\times\frac{26-3y}{4}-8y=19$. Now, multiplying the numerator by 7 and the equation of y by 4, we get $182-21y-32y=76$, *i.e.* $53y=106$, and therefore $y=2$. Taking next this (found) value of y [*i.e.* 2], let us substitute it in seeking the value of x. This gives the formula $x=\frac{26-6}{4}=\frac{20}{4}=5$. That these numbers satisfy the conditions of the problem we see, for $5\times4+3\times2=26$, and $5\times7-8\times2=19$.

(2) In the second method we bring the two [given] equations as equal values into direct comparison, thus: $x=\frac{26-3y}{4}$ and $x=\frac{19+8y}{7}$, that is $\frac{19+8y}{7}=\frac{26-3y}{4}$. Multiplying the numerator of each by the denominator of the other we gain $76+32y=182-21y$, that is $106=53y$; $\therefore y=2$. Whence we find $x=5$, as before.

(3) In the third method the question is wrought thus:—Setting out to eliminate y, we multiply the former equation by 8, the coefficient of y in the latter, and the latter by 3, the coefficient in the former; thus $4x+3y=26$ becomes $32x+24y=208$, and $7x-8y=19$ becomes $21x-24y=57$. This gives us $53x=265$, that is $x=5$. In the same way, multiplying the former by 7 and the latter by 4, we have x eliminated and $53y=106$, that is $y=2$, as in the previous forms of working.

It is often possible to employ in the work of elimination those principles of cancelling which are in use in the case of reduction of fractions. Let, for instance, the two equations be (1) $15x+6y=132$, and (2) $3x+8y=74$. The former equation becomes, on being divided by 3, $5x+2y=44$. On looking at the latter we observe, $8y$ being divided by the $2y$ in the former yields 4 as the quotient. By this 4 we multiply the former reduced equation, and it becomes $20x+8y=176$. From this, y being eliminated, we subtract the latter equation, thus $20x-3x=176-74$, that is $17x=102$, so that $x=6$. If the student now substitutes this value of x, and uses it in the resolution of the other equation, he will find that in this case $y=7$.

In the next operation we shall merely indicate the results of each step, leaving the student to work out the process.

Given, (1) $2x+5y=23$, and (2) $3x-2y=6$, to find the respective values of x and y. The former yields

$$x=\frac{23-5y}{2},\ \text{the latter}\ x=\frac{6+2y}{3},\ \therefore\ \frac{23-5y}{2}=\frac{6+2y}{3}.$$

Thus, after due clearing and transposition, these yield $-19y=-5y$, from which the value of y is of course easily found. Again, substituting the value of x in the other equation, we have given us $\frac{2(6+2y)}{3}+5y=23$, which, after clearing and removing brackets, yields $12+4y+15y=69$, and this will give the value sought, viz. $y=3$.

Hence x, that is $\frac{6+2y}{3}=\frac{6+6}{3}$, wherefore $x=4$.

Once more, multiplying the former by the coefficient of x in the latter, and the latter by the coefficient of x in the former, we get $\begin{matrix}6x+15y=69\\6x-\ \ 4y=12\end{matrix}$, and hence $y=3$. Then multiplying the former by the coefficient of y in the latter, and the latter by the coefficient of y in the former, we have $\begin{matrix}4x+10y=46\\15x-10y=30\end{matrix}$, which yields $19x=76$, *i.e.* $x=4$.

The following are the rules of method usually employed with equations which involve two unknown quantities:—

1. *Substitution.*—Find an expression for either of the unknown quantities from one of the equations, and substitute it for that unknown quantity in the other equation. The result will then be an equation containing only one unknown quantity, and it may, therefore, be solved by the methods explained in the three preceding chapters, IX.-XI.

Let the proposed equations be of the general form

$$ax+by=c \qquad a'x+b'y=c'.$$

In such a form of question it may be as well to say, that to avoid using many different letters, it is common to employ the same letter with one or more accents, to signify different numbers. Thus the symbol a' differs as effectually from a as a does from b. As to the naming of the numbers for which they stand, a' may be read "a" *accented.* The same remark applies to b', c', or any other accented symbol.

Taking now the first of the equations, we get at once $x=\frac{c-by}{a}$. Substituting this value for x in the second, we have

$$(1)\ a'\left(\frac{c-by}{a}\right)+b'y=c', \text{ or } (2)\ \frac{a'c-a'by}{a}+b'y=c',$$

whence there results quite readily $y=\frac{ac'-a'c}{ab'-a'b}$.

To obtain x (1) find y from the first equation, and repeating the process, find

$$y=\frac{c-ax}{b} \qquad a'x+\frac{b'c-ab'x}{b}=c' \qquad x=\frac{bc'-b'c}{a'b-ab'}.$$

Or (2) substituting the value of y first obtained in the previous expression for x, proceed thus—

$$x=\frac{c-by}{a} \qquad by=\frac{abc'-a'bc}{a'b-a'b}$$

$$c-by=\frac{abc-a'bc-(abc'-a'bc)}{ab'-a'b}=\frac{ab'c-abc'}{ab'-a'b}=\frac{a(b'c-bc')}{ab'-a'b}$$

$$\therefore\ \frac{c-by}{a}, \text{ or its equivalent } x=\frac{b'c-bc'}{ab'-a'b}.$$

The student may now work out this numerical example. Find the values of x and y from the two equations—

$$(1)\ \tfrac{1}{2}x+\tfrac{1}{4}y=6\tfrac{1}{2}, \text{ and } (2)\ \tfrac{3}{8}y-\tfrac{1}{10}x=\tfrac{33}{40}.$$

In this, as in all similar instances, begin by clearing away the fractions; this gives $2x+y=26$, and $15y-4x=33$.

Find first the value of the least involved unknown quantity, which, here, is y in the former equation; we get $y=26-2x$; and this value, substituted for y in the second equation, gives $15(26-2x)-4x=33$; whence $x=10\frac{1}{2}$.

Using this value of x in the expression for y, gives $y=5$.

2. *Equating.*—Find a value of one of the unknown quantities from each of the equations, and equate these values [*i.e.* make them the members of a new equation]. The resulting equation will contain only one unknown quantity, *e.g.*—

$$(1)\ ax+by=c, \text{ and } (2)\ a'x+b'y=c'. \quad \text{This yields}$$

$$(1)\ y=\frac{c-ax}{b},\quad x=\frac{c-by}{a}.\quad (2)\ y=\frac{c'-a'x}{b'},\ x=\frac{c-b'y}{a'}.$$

Equating (1) the values of y, and (2) those of x with each other,

$$\text{We get } (1)\ \frac{c-ax}{b}=\frac{c'-a'x}{b'}, \text{ whence } x=\frac{b'c-bc'}{ab'-a'b}.$$

$$\text{And } (2)\ \frac{c-by}{a}=\frac{c'-b'y}{a'}, \text{ whence } y=\frac{ac'-a'c}{ab'-a'b}.$$

The following numerical example exemplifies what has been said. Find the values of x and y from the equations

$$(1)\ x+\frac{3y-2x}{7}=12\tfrac{3}{7}, \text{ and } (2)\ \frac{7x-9y}{3}=1.$$

These equations, when reduced to their simplest forms, are $5x+3y=87$, $7x-9y=3$. From these we get

$$(1)\ y=\frac{7-5x}{3},\ x=\frac{87-3y}{5}.\quad (2)\ y=\frac{7y-3}{9},\ x=\frac{3+9y}{7}.$$

$$\therefore\ \frac{87-5x}{3}=\frac{7y-3}{9},\ i.e.\ x=12.\quad \therefore\ \frac{87-3y}{5}=\frac{3-9y}{7},\ i.e.\ y=9.$$

3. *Equalizing the Coefficients.*—Reduce and multiply or divide (as is the more convenient) both equations in such a way that the terms which contain the same unknown quantity in each equation, may have the same coefficient; then (1) if the signs of the terms whose coefficients are thus equalized be unlike, add the two resulting equations together, but (2) subtract the one from the other if the signs be like. One of the unknown quantities will thereby be eliminated. Having found the value of one of the unknown quantities from this new equation, the value of the other may be determined either by repeating the process upon the given equations, or by substituting in either of them the value of the unknown quantity already determined.

Practically, in general, the shortest method of equalizing the coefficients is this: *Multiply each equation by the coefficient which the quantity to be eliminated has in the other equation*, e.g.—(1) $ax+by=c$, and (2) $a'x+b'y=c$.

(1) To eliminate x and find y, multiply the former by a', and the latter by a. We then get

$$(1)\ aa'x+a'by=a'c, \text{ and } (2)\ aa'x+ab'y=ac'.$$

Subtract either of these products from the other: the first from the second gives

$$(ab'-a'b)y=ac'-a'c \qquad \therefore\ y=\frac{ac'-a'c}{ab'-a'b}.$$

(2) To eliminate y and find x, multiply the former by b', and the latter by b; we get

$$ab'x+bb'y=b'c. \qquad a'bx+bb'y=bc'.$$

Subtract one of these products from the other; the second from the first gives

$$(ab'-a'b)x=b'c-bc' \qquad \therefore\ x=\frac{b'c-bc}{ab'-a'b}.$$

Numerical examples are worked in the same way: *e.g.*

$$(1)\ 3x-\frac{x-y}{2\frac{1}{2}}=2y+11, \text{ and } (2)\ 6y-\frac{2y-x}{4}=3x+y+1.$$

These equations, reduced to their simplest forms, are

$$(1)\ 13x-8y=55, \text{ and } (2)\ 18y-11x=4.$$

To eliminate x, multiply (1) by 11 and (2) by 13, and we get

$$(1)\ 143x-88y=605, \text{ and } (2)\ 234y-143x=52.$$

The signs of the terms containing x are unlike, therefore add the results, and get $146y=657$, whence $y=4\frac{1}{2}$. This value of y substituted in the equation $13x-8y=55$, gives $13x-36=55$, whence $x=7$.

Since, then, two equations are necessary and sufficient for the determination of two unknown quantities, when an algebraical problem requires for its solution the determination of two unknown quantities, it must give rise to an equal number of (1) independent, (2) consistent equations, and (3) no more.

1. *The equations must be independent*—that is, each must contain a separate condition not fulfilled by the other, and not derivable from it. For instance, the equations (1) $x+y=15$ and (2) $x-y=7$ are independent of one another, as they involve separate conditions regarding x and y. But the equations $2x+2y=30$, $\frac{1}{2}x+\frac{1}{2}y=7\frac{1}{2}$, are both deducible from $x+y=15$, and do not involve any new condition. They are therefore dependent, admit of all the solutions of the original equation, and are unnecessary.

2. *The equations must be consistent*—that is, they must not contradict each other, as the following do:—$x+y=10$, $x+y=12$, which are evidently incongruous, and cannot both be satisfied with one set of values of x and y. The first subtracted from the second gives $(x+y)-(x+y)=12-10$, that is, $0=2$, an absurdity parallel to $ax=ax+1$.

3. *The number of equations must not exceed the number of magnitudes to be determined.* If, for instance, *three* equations be proposed to determine the values of *two* unknown quantities, (1) one of the equations will be dependent on, or deducible from, the others, and therefore unnecessary; or (2) it will be incompatible with both the others, though not inconsistent with either of them taken singly. Taking, for example, the equations $x+y=11$, $3x-2y=8$, $7y-x=13$, and solving them pair and pair together; we find that

The first and second are true if $x=6$ and $y=5$.
The first and third are true if $x=8$ and $y=3$.
The second and third are true if $x=4\frac{6}{19}$ and $y=2\frac{8}{19}$.

The following examples show how problems requiring the determination of two unknown magnitudes are translated into algebraical language:—

PROBLEM I.—Nine men and seven women receive together £3 11*s.* 2*d.* for their wages, and it is found that seven men receive 19*s.* 8*d.* more than five women: required—the wages of each person?

Let x and y represent the wages of each man and woman respectively in pence; then, by the question, we have

$$\left.\begin{aligned}9x+7y&=£3\ 11s.\ 2d.=854d.\\ 7x-5y&=£0\ 19s.\ 8d.=236d.\end{aligned}\right\}\ \text{whence}\ \left\{\begin{aligned}x&=63d.=5s.\ 3d.\\ y&=41d.=3s.\ 5d.\end{aligned}\right.$$

PROBLEM II.—A farmer mixed barley at 2*s.* 4*d.* a bushel, with rye at 3*s.*, and wheat at 4*s.* per bushel, then he found that 100 bushels of the mixture was worth 3*s.* 4*d.* per

bushel. Had he used double the quantity of rye and 10 bushels more of wheat, the whole would have been worth exactly the same per bushel. Required the quantity of each kind of grain in the mixture?

Let x = the number of bushels of barley, and y = the rye; then $100-(x+y)=100-x-y$ = the bushels of wheat.

Now, $28x+36y+48(100-x-y)$ is the price of the whole in pence; but 100×40 is also the price of the whole at 3*s.* 4*d.* per bushel.

$$\therefore 28x+36y+48(100-x-y)=4000. \qquad (1)$$

Again, on the second hypothesis, we get similarly

$$28x+72y+48(110-x-y)=40(110+y). \qquad (2)$$

$$\left.\begin{array}{l}\text{From equation (1) we get } 5x+3y=200\\ \text{From equation (2) we get } 5x+4y=220\end{array}\right\}\text{ whence }\left\{\begin{array}{l}x=28.\\ y=20.\end{array}\right.$$

Also, $100-x-y=100-28-20=52$; so that the answer is 28 bushels of barley, 20 of rye, and 52 of wheat.

EXERCISES.

		Ans.
1. (1) $x+y=10$,	(2) $2x-3y=5$.	$x=7$ and $y=3$.
2. (1) $2x+5y=26$,	(2) $5x+6y=39$.	$x=3$ " $y=4$.
3. (1) $2x+3y=13$,	(2) $5x-4y=22$.	$x=2$ " $y=3$.
4. (1) $11x-10y=14$,	(2) $5x-7y=41$.	$x=4$ " $y=3$.
5. (1) $3x+5y=31$,	(2) $4x-y=26$.	$x=7$ " $y=2$.
6. (1) $2x-3y=7$,	(2) $3x-4y=12$.	$x=8$ " $y=3$.

ASTRONOMY.—CHAPTER XIV.

SPECTRUM ANALYSIS—SOLAR PHYSICS—FRAUNHOFER'S DISCOVERIES—KIRCHHOFF'S DISCOVERIES—HIS THEORY OF THE CONSTITUTION OF THE SUN—DETERMINATION OF VELOCITY BY THE SPECTRUM—CONSTITUTION OF THE SUN—TELLURIC LINES.

DURING the last few years spectrum analysis, or the determination of the constituent elements of a luminous body by the examination of its light after its passage through one or more prisms, has become an invaluable auxiliary to the progress of astronomy. Although spectrum analysis is fully considered in NATURAL PHILOSOPHY, a few general observations are repeated here to enable the science of spectroscopy, as applied to the heavenly bodies, to be fully understood.

Newton first demonstrated that a ray of white light is in reality complex, and compounded of various coloured rays of light, and that sunlight is decomposed into its elementary rays when the pencil of light is passed through a glass prism. The image thus thrown on to a screen is termed the solar spectrum, and the image formed by the light of any luminous body, after it has passed through a prism, is said to be the spectrum of that body. The rainbow-coloured strip of the solar spectrum consists of a multitude of overlapping images of the aperture through which the light was admitted, each different coloured light forming its image on its own proper part of the spectrum. The seven primary colours of the spectrum are violet (the most refrangible), indigo, blue, green, yellow, orange, and red. None of these can be again subdivided: red or yellow light passed through another prism will still be red or yellow light. In 1814 Fraunhofer discovered that the solar spectrum was crowded over its entire length with fine dark lines; so numerous were these that he counted 576, and the darkest of them he distinguished by the letters A, B, C, D, E, F, G, H (see Solar Spectrum, fig. 7, Plate XI.) He proved that these same lines were always seen invariable in their position, whatever the prism employed; and further, he found that sunlight, whether viewed directly or reflected from the clouds, moon, or planets, gave the same spectrum. He also examined the light from the stars, and found that their spectra were likewise crossed by dark lines, but grouped differently in different stars, and in none exactly like those of the solar spectrum. This fact, therefore, proved that the cause of these lines did not lie in our own atmosphere or in general space, and established the fact that their origin lay in the sun and stars themselves. One other fact Fraunhofer also proved: that the spectrum of an artificial light—a candle, for instance—was continuous, and had no black lines crossing it like the solar spectrum; but in the orange, where the two D lines are, in the solar spectrum he noticed a pair of bright lines, since known to be due to the presence of sodium. In 1859 Kirchhoff, in order to test in the most direct manner the assertion of the coincidence of the sodium lines with the line D in the solar spectrum, as seen by Fraunhofer, obtained a bright solar spectrum, and brought a flame, coloured by sodium vapour, in front of the slit of the spectroscope. He then noticed that the dark lines D of the solar spectrum changed into bright lines. The flame of a Bunsen's lamp threw the bright sodium lines upon the solar spectrum with great brilliancy, but when the full sunlight was allowed to pass through the sodium flame, the dark lines D appeared with remarkable clearness. When, instead of sunlight, limelight was used, and allowed to pass through a suitable flame coloured with sodium, dark lines were seen in the spectrum in the position of the sodium lines; and instead of the brilliancy of the continuous spectrum of the limelight being increased in the yellow by the interposition of the sodium flame, it was actually darkened, and as far as the two lines of sodium were concerned an artificial solar spectrum was produced. The interpretation of these two experiments of Kirchhoff's enunciates the principle upon which the spectroscope is applied to astronomy—namely, that if light giving a perfectly continuous and complete spectrum be intercepted by a glowing vapour, or gas giving a spectrum of bright lines, that light which corresponds to the bright lines will be stopped, as the gas will be opaque to it, and the remainder only will pass. As the glowing gas is emitting light of the very same quality as that which it absorbs, if it be at the same temperature as the source of the white light it will emit as much as it receives, and thus give no sign of its presence. If it be hotter it will give off more than it receives, and hence cause *bright* lines; and only if it be the cooler will it emit less light than it absorbs, and so occasion *dark* lines, and the greater the difference of temperature the darker the lines. From these results Kirchhoff considered that the sun is composed of a highly heated nucleus, termed the photosphere, yielding a perfectly continuous spectrum, and surrounded by less highly heated vapours, sodium vapour being one, the spectra belonging to which give bright lines coincident in position with the Fraunhofer lines; and it necessarily follows that the lines in the spectra of stars have to be interpreted in the same manner. From Kirchhoff's principle it follows that if the absorbing vapour itself gives a spectrum of bright lines, the dark lines it causes will exactly correspond to them, and hence be as sure an indication of its presence as the bright lines would be. The researches of Huggins, Lockyer, and Frankland, have shown how to interpret variations in the width of a line—an increase of pressure causing the lines to widen equally in both directions. A twist or widening in one direction only, or an entire displacement, is due to another cause, and it enables the rate at which a luminous body is approaching or receding from us to be determined. The impression of colour made on the eye depends on the interval between the waves of light as they enter it. The longest waves produce the sensation of red, the shortest of violet. If therefore a stream of glowing hydrogen is rapidly approaching the observer, a greater number of waves of light from it will enter his eye in a second than if the source of light were at rest, and therefore the interval between the waves, or the wave-length, would appear to be diminished. If therefore a line, say corresponding to F, were under examination, it would seem to be more of a violet hue than before, and will appear displaced in the spectrum in that direction, as compared with the same line given by the hydrogen in a vacuum-tube, or with other lines in the sun, the elements producing which are at rest. In like manner, if the source of light be receding, the waves of light will seem lengthened, and any particular line will appear to be displaced towards the red end of the spectrum. Thus spectroscopic astronomy has solved many important problems hitherto rgarded as quite beyond our reach. Still, whatever may be the theories developed regarding the physical constitution of the sun and stars, &c., every explanation must always be based upon the discoveries of Kirchhoff, and the various details of any theory in explanation of the solar spots, the feculæ, the prominences, &c., must be in strict

accordance with the phenomena established by Kirchhoff of the absorption of the coloured rays and the reversal of the spectrum. Kirchhoff having succeeded in explaining the presence of two of the solar lines, pursued his investigations with the spectrum of iron, which contains some 450 lines, and found that every bright line in the spectrum of iron had its counterpart in a dark line in the solar spectrum, that each strong line was represented by a strong line, and each faint line by a faint line. The researches of Kirchhoff, Bunsen, and Angström, of Upsala, resulted in the discovery that the spectra of some thirteen or fourteen elements gave bright lines corresponding with solar lines, while several others, as gold, silver, tin, lead, antimony, arsenic, mercury, cadmium, strontium, lithium, gave no lines of coincidence.

The following table shows the elements recognized in the solar atmosphere, and the number of coincidences established.

Hydrogen,	4	Manganese,	57
Sodium,	9	Chromium,	18
Barium,	11	Cobalt,	19
Calcium,	75	Nickel,	33
Magnesium,	4	Zinc,	2
Aluminium,	2	Copper,	7
Iron,	450	Titanium,	118

The absence of dark lines corresponding to the bright lines of any element is no indication that it may not exist in the sun. For it may be at such a temperature as to emit about as much light as it absorbs, or its vapours may be so heavy as not to rise above the level whence the white light of the sun proceeds. But the number of elements already mapped out warrant the belief that the substances constituting the chief mass of the sun are, without doubt, the same substances as exist on the earth.

Some of the dark lines seen in the sun's spectrum are due to the influence of the earth's atmosphere, and are termed *telluric lines.* Sir David Brewster had noticed, long before Kirchhoff's discovery, that certain lines which were dark and strong when the sun was on the horizon, grew faint or disappeared altogether when it was high in the heavens. The experiments of Janssen proved that these lines were due to absorption from the presence of aqueous vapour in the earth's atmosphere. The absorption spectrum of aqueous vapour consists therefore of all the lines introduced into the continuous spectrum by the aqueous vapour of the earth's atmosphere. The investigations of Janssen further proved that the telluric lines were also found in the spectra of the fixed stars, evidently absorption bands common to both the sun and the stars when near the horizon.

The spectroscopic examination of sun-spots (Plate XI.) by Secchi, Lockyer, and Huggins, show that notwithstanding the darkness of the spot the continuous solar spectrum does not disappear. The general appearance presented by the spectra of the different parts of a spot is shown in fig. 8, Plate XI. No. 1 shows the position of the slit of the spectroscope on the spot; No. 2, the portion of the spot covered by the slit which is viewed by the observer. The portions A B, E F, at either end, belong to the surface of the sun, the middle part, C D, to the umbra of the spot, and the parts B C and D E to the penumbra. No. 3 shows the spectrum of these five parts, the centre one that of the umbra, on each side of it a spectrum of the penumbra, and outside these the ordinary solar spectrum. The spectrum of the spots is always much fainter than that of the sun's disc, a circumstance which indicates an increase of general absorption, and individual lines frequently appear increased in breadth and intensity, as shown in the double D line. The lines due to sodium, iron, and magnesium are generally affected, and especially those of titanium, barium, and calcium; and as the sodium lines are affected in a smaller degree it may be considered that these substances compose chiefly the vapours of a spot, occurring in layers of varying thickness and in very different proportions. Although no new lines are seen in the umbra of a spot, Lockyer has observed a line both dark and bright at the same time, the dark part being bent towards the red, and the bright part to the violet, indicating that there was a down-rush of cooler gas from the surface, and a corresponding ejection of the more highly heated gases of the interior. That hydrogen gas constitutes an important element in the formation of the spots is shown by the singular twistings and bendings in particular lines over a spot, especially the F line due to hydrogen, showing movements and variations of pressure of the most complicated character (fig. 5, Plate XI.) The spectra of different parts of a spot are not always identical. Secchi examined a spot crossed by a brilliant ridge, in which the hydrogen lines were bright instead of dark, while in the penumbra no hydrogen lines either dark or bright could be traced, the umbra showing the absorption bands ascribed to aqueous vapour. The evidence of the spectroscope on the constitution of a spot therefore indicates that the general absorption is much increased, and that many vapours and gases are at a much greater pressure there than at the general surface of the sun; hydrogen, and at times other vapours, rushing down with great velocity into its depths—a movement which is sometimes compensated for by the up-whirling of immense masses of glowing gases from the strata below. The enormous dimensions of these dense masses of vapours, which sometimes extend in all directions, account for the length of time the spots at times continue visible. The spectrum of the feculæ, from Lockyer's observations, is brighter than that of the sun's general surface, and frequently individual lines are found to be missing—circumstances which would seem to indicate that the feculæ are elevations above the sun's ordinary surface, and therefore seen through a less depth of the solar atmosphere.

Total eclipses of the sun had long since revealed the fact that the sun was surrounded by appendages of the strangest character (fig. 1, Plate IV.), being enveloped on all sides by a narrow but brilliant ring of silver whiteness, termed the *corona*, from which stream out in all directions faint rays of light irregular in length and breadth, and surrounding the moon's limbs like a halo. When the total darkness commences the prominences make their appearance (fig. 5), cloud-like masses of a red colour, disposed either singly or in groups at various places round the moon's limb. The origin and nature of these appearances were involved in mystery until the spectroscope showed that these remarkable phenomena belong to the sun, and are nothing but vast accumulations of the luminous gaseous material by which the solar body is wholly surrounded, termed the *chromosphere.* These enormous mountains, principally of luminous hydrogen gas, extend at times beyond the limb of the sun to a height exceeding 80,000 miles (figs. 3, 4, Plate IV.)

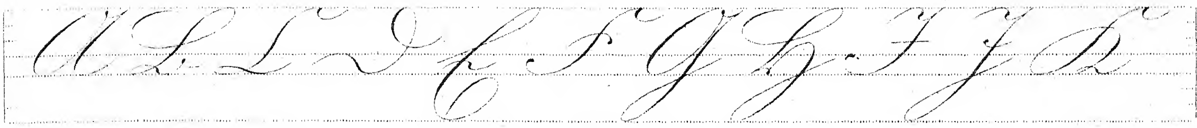
The spectrum of the prominences (fig. 1, Plate XI.) consists of some bright lines of intense brilliancy, among which the Hα (C), Hβ (F), and Hγ (G) are especially noticeable. The line in the yellow close by the D lines, and known as D^3, is not found in the spectrum of any known element, nor is any corresponding dark line usually seen in the solar spectrum. The bright lines of other elements frequently appear in the spectrum of the prominences or chromosphere, but they do not attain nearly the same height that the hydrogen lines do. Sodium, magnesium, and iron are frequently observed. Occasionally these heavier metals are projected to much greater heights, and Lockyer has observed a cloud of magnesium vapour floating over a prominence. The bright lines of hydrogen generally taper towards a point; this is particularly the case with the line Hβ, the arrow-headed appearance of which (fig. 10, Plate XI.), close to the edge of the disc, has often been observed by Lockyer, Young, and others, and plainly indicates that the pressure rapidly diminishes from the limb outwards. The metallic lines likewise appear thinner when seen bright in the chromosphere than when seen dark on the sun. The three bright lines of the spectrum of the corona are shown in fig. 2, Plate XI. It will be observed that these three lines are wanting in the spectrum of the prominences, and what invests these three lines with a peculiar interest is the circumstance that they appear to coincide exactly with the first three of the five bright lines in the spectrum of the aurora borealis (fig. 3). The brightest of these lines is the reversal of a strongly-marked Fraunhofer line, E, belonging to the vapour of iron.

The light of the corona is not that of reflected sunlight, since none of the dark lines are contained in its spectrum; and the conclusion is that the corona is self-luminous, and

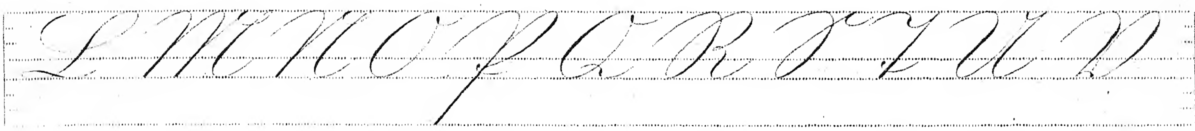
PENMANSHIP

GERMAN HANDWRITING

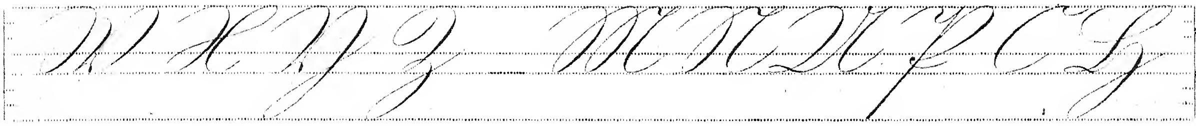
Capitals



A B C D E F G H I J K

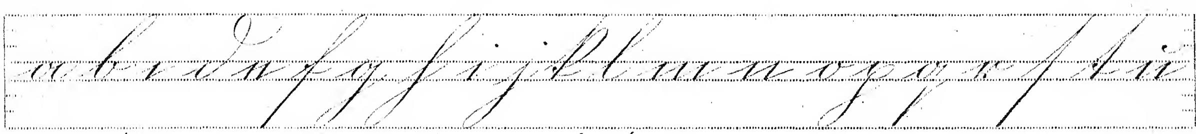


L M N O P Q R S T U V

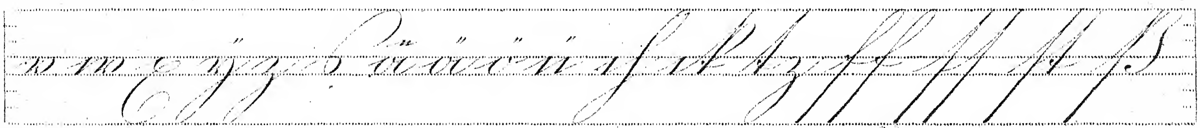


W X Y Z M N U P C H

Small Letters

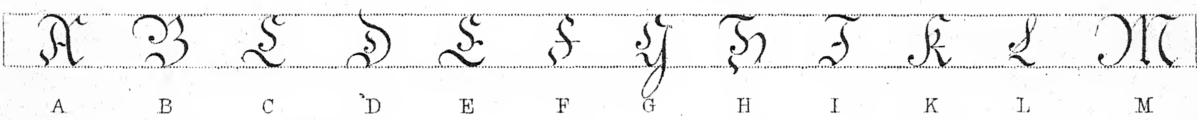


a b c d e f g h i j k l m n o p q r s t u

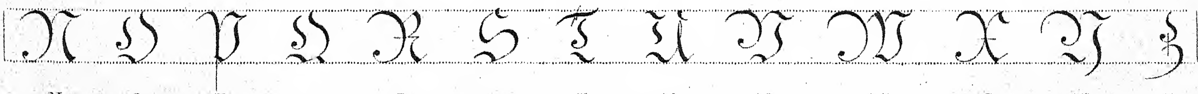


v w x y z s ae oe ue ch ck tz ff ss st ss

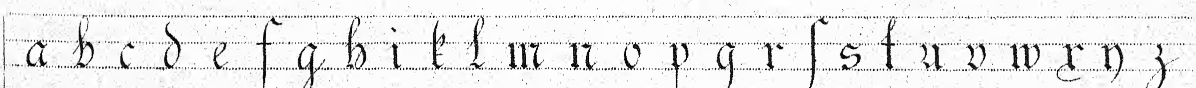
English Engrossing Hand



A B C D E F G H I K L M



N O P Q R S T U V W X Y Z



a b c d e f g h i k l m n o p q r s s t u v w x y z

belongs to the sun. The question as to its precise nature is, however, as yet undetermined, although it was found possible in 1883 to photograph it even without the assistance of an eclipse by using suitable media to intercept the light from the sun. In the photograph of the corona (fig. 2, Plate IV.) the prominences are clearly defined, and also the remarkable rifts or dark spaces in the corona.

The various spectroscopic observations made of the sun lead to the following conclusions regarding its constitution: the body of the sun, or its light-giving envelope, the photosphere, is completely surrounded by a gaseous envelope, in which hydrogen forms the chief element; this is called the chromosphere, and its mean thickness is between 5000 and 7000 miles. The solar prominences are local accumulations of the chromosphere, and therefore chiefly composed of hydrogen gas, which appears to break forth from time to time from the interior of the sun in the form of vast eruptions, forcing their way through the photosphere and chromosphere; this gas is projected with great velocity, and becomes rapidly rarefied in a direction away from the sun's limb.

As in the spectrum of the chromosphere the hydrogen line $H\beta$, corresponding to the line F, in general takes the form of an arrow-head (fig. 10, Plate XI.), the base of which rests on the sun's limb, and as the widening of this line is the result of an increase of temperature as well as of pressure in the lowest stratum of the chromosphere, the pressure and temperature of the gas must be greater than in the upper part, and from experiments made by Lockyer, Frankland, and Secchi it is assumed that this pressure is smaller than that of our atmosphere, and therefore that the gas of the chromosphere is in a state of greater attenuation. The swelling out of the line $H\beta$ at times observed (fig. 11, Plate XI.) is probably due to the sudden and violent meeting of the streams of gas causing their condensation. The vapours of the photosphere under the chromosphere, which contain all the substances giving the absorption lines in the solar spectrum, among which are iron, magnesium, and sodium, often burst through the chromosphere in a state of incandescence, and are carried up a certain distance into the bases of the prominences. Kirchhoff's theory that the solar nucleus is surrounded by an extensive non-luminous and comparatively cool absorptive atmosphere therefore gives place to that of the glowing and light-emitting photosphere, being surrounded by a luminous and intensely hot stratum of gas, the chromosphere, the spectrum of which consists mainly of hydrogen gas, and it is probable that, owing to a continuous decrease in its temperature and density, the chromosphere stretches out into space to a distance far beyond what it is possible to detect.

Observations of the prominences distinguish them into two forms, *eruptive* and *vaporous* or cloud-like forms; these forms are shown in their natural colours, figs. 3 and 4, Plate IV., and serve to illustrate the remarkable changes of the prominences in form. These enormous masses of flaming gas sometimes extend along the sun's limb for a distance of 224,000 miles, and attain a height of over 80,000 miles. In the sun's polar regions prominences occur only occasionally; they are most frequent at about 45° N. lat., in a region where solar spots are rarely seen. The prominences are therefore phenomena quite distinct from sun-spots, and are probably intimately connected with the formation of feculæ. The various forms of the prominences prove that they are not of the nature of clouds floating in an atmosphere, but partake of the nature of eruptions from the interior of the sun, and their extreme rapidity of motion necessitates the hypothesis of a repulsive power at work either at the surface or in the mass of the sun.

PENMANSHIP.—CHAPTER XIII.

GERMAN HANDWRITING—SMALL LETTERS AND CAPITALS ANALYZED AND EXPLAINED.

The written, no less than the printed, German characters differ from those which are now called Roman. On turning to Plate III. (PENMANSHIP) this will be sufficiently obvious at a glance. At first sight the close resemblance of many letters to each other, and the want, in many of the characters, of a sufficiently distinct and individual form of their own, will probably excite a sense of difficulty, and may even tax the patience of the learner. Let him not, however, too hastily shrink from the apparently hard task of acquiring a graphic power over German handwriting. Care, industry, and perseverance are capable of aiding in more arduous achievements even than this. We know that the best writers and scribes in the middle ages used this form of script with readiness and ease. It is the form in which the most learned race in Europe represent their thoughts, and in this script the manifold business transactions of the commerce of Germany is conducted. It is, though a difficult, not an impossible task, and intelligent observation may perhaps, if we try earnestly, help us to an arrangement by which we may pass from simple to complex with complete success.

Examining Plate III. as a whole, we notice at once (1) that sharp angles constitute a characteristic feature of the small letters of the alphabet, while among the capitals circular forms and hooks prevail; (2) that in all the letters the thick stroke, as is indeed natural, always takes the same direction, slanting downwards from right to left; and (3) the minuscules are, in proportion to the majuscules, rather smaller than is usual in English writing. Endeavouring next, among the unfamiliar forms, to select those which most nearly resemble the ones in our own script alphabet, we may pick out (1) of those formed by the primary element *i* [*i.e.* a top hair-stroke slanting from left to right, attached at a sharp angle to a thick down-stroke slanting from right to left, and another sharply-angled hair-stroke carried from the foot of the down-stroke, with an upward slant from left to right] the following:—*i*, consisting of the primary element described—with, as in English, a dot over it, which must never be forgotten; *n*, two of these conjoined; *u*, the same, with an inverted comma-like tick over it; and *m*, three primary elements conjoined. Taking these as helps with us, we may next search for any similar or analogous forms, and try to fix them in our memory according to their nearness or remoteness of likeness to those we have recognized. Of these perhaps the nearest and the most peculiar to our eyes is *e*. This consists of the first two elements of the primary *i*, with the last two elements of the same primary placed parallel to each other, near but not touching each other [and generally a slight horizontal hair-stroke is used to connect at the top the two thick down-strokes]. Next comes *c*, which is a primary *i* with either a small dot or a concave curved line attached to the right of the top of the down-stroke, but when it precedes *h* or *k* the dot or curve is not used; *o*, a primary *i* with an inwardly curving line rising from foot to top; *d*, the same, with an elongated terminal inward curve rising three lengths of the primary; *a*, an *o* with a primary *i* attached to the right of it; *g*, an *o* with a sharply curved tail, like an English *j*, attached to the right—*q* is, as in English, like *g*, with the tail curving sharply round towards the right; and *z* is formed of a primary *i*, with the tail attached to the hair-stroke at the foot. So far, we have been guided from the known to the unknown, until we have got back again among known but variously compounded forms. For not only do *g*, *q*, and *z* resemble their analogues in English, but *j*, *l*, *f*, *b*, and even *t*, may be regarded as resemblant forms. The letter *h* is like an English old-fashioned long *s*, such as is sometimes even yet used in words in which *ss* occur. The German letter *s* is formed like the initial long stroke of the English minuscular *p*; but to it is also given, as a final letter, the form of a figure 6, begun to be made at the lower circle, taking it from left to right, and circling round at the top with a heavy stroke curve. We might almost adopt the letter *k* as English in form, only that its curvilinear upper hoop-line is larger. Taking its thick down-stroke as formed like the first element in an English *k*, it is unlooped at the top; but the loop is formed in the middle, brought down to the main-line, and has then a primary *i*-form added. The "dog-letter" *r* is quite unlike any we use; it consists of a primary *i*, the foot hair-stroke of which is looped round in a very small circle, then carried up to the usual level, and

has formed there a half-sized primary *i*. The letter *v* is like the letter *r*, except that when the stroke from the small circle is carried up it is finished off by a round black inward-curving stroke [*a* and *v*, when properly written, are the one like the other when either is turned upside down]. The *w* is formed by prefixing [*i.e.* placing on the left] a primary *i* to *v*. If the curve on the right of *v* is taken down below the line like a *j*, *y* will be formed. The letters *p* and *x* are formed from the primary *i* by twirling the second hair-stroke round in the former so as to make a circle about the size of the letter, and adding thereto a tail like a *j;* in the latter the attached tail is curved outwardly, in such a way that the whole of the latter part takes the shape of an English capital C. This concludes the analysis of the alphabet proper, but the double consonants require a short notice. The combinations *ck* may be regarded as represented by a primary *i* and a long *s* English or *h* German; *sch* by an English *p* and a long *s*; *ss* (medial) simply repeats the latter form, but when terminal both forms noted above are united; *sz* and *st* are simply united. Some other signs which have now become antiquated are to be found in old MSS. and books.

In the analysis of the capitals, the best way, as shown in the small letters, is to search for all such as possess likeness to those with which we are familiar in our own script characters. But, in doing so, we must exercise considerable care. In O we have quite our own form; L is pretty nearly so; but both B and C present a somewhat close approach to their forms in the main stem at least. The former, however, differs from it in having a dot and a curved line affixed to the lower terminal curve, while the latter takes as its distinctive feature, instead of the crossing ovalesque curve, a dot and curve at the top of the main line. The German letter F has the same stem-line, but it terminates in a dot on the left, and the stem is crossed in the middle by a horizontal straight line; while a common shape of F in English is allotted to the letter I—J, as in English, has the upper form of I, terminating in an elongated oval curved loop passing below the line—and T, while it has the same main-stem as I, ends bluntly on the line, and has a dot and curve drawn through the foot of it just slightly above the line. The letter X is readily recognized; Z differs but little from the English form; E takes exactly the shape of our letter C, but one half of it passes below the line, and a waved stroke crosses the letter upon the line between the upper looped part and the lower oval curved scroll; and R is very like its English namesake, only that it is begun from the left. We have a commercial contraction for *per* in ₱, which pretty well reproduces P. If we omit the last element of R, *i.e.* the inverted line of beauty at the end, we produce the German S. Somewhat like an ordinary English R badly or hastily formed, with the line of beauty rather trailed along the line, is the German K, but, perhaps to show its kinship, it imperatively requires a dot and curved line similar to that which is placed at the top of C. The capital H, more nearly than anything else, resembles an English G inverted; it might almost be regarded as a long *s* broken and joined by a curve. If the student examines the earlier half of P and R he will find that they commence about midway down on the left, and that they form towards the right a heavy-lined curve, matched with a hair-stroke curve on the left, and that the lines in crossing inclose an elongated oval. This special ellipse is a main element not only in these two characters, but also in several others. For example, N is made up of such an ellipse with an element resembling the figure 7 attached to it; two of these with the same 7-like form combine to make M. An O with the same numeral-like terminal produces A; G takes the form of A with a long tail attached to it on the right; and Q may either appear as G with the tail turned the reverse way, or as an G with a dot and curved line attached to the bottom of it, as in the English capital Q. U is shaped like an English V with a 7-like final; V is like an A inverted, and consists of an ordinary pothook, to which a curve like the first element in X is joined. W is a V with the first element in N prefixed; and Y may best be described as a minuscular *y* enlarged; and as it may possibly be of some use, we may note that A, G, V, W, and Z are each enlarged forms of the small letters, with curved rather than angular connections at top and foot. Perhaps the Greek ϑ is the character which most nearly resembles the German D. It is begun by forming a Hogarthian line of beauty on the horizontal level of the writing; it then proceeds by an upward hair-stroke curve from right to left to the full height of a capital, when the line circlingly returns upon itself, crosses and curves upward in a final hair-stroke curve. Of double letters only the first is written as a capital.

We have thus endeavoured to guide the observative faculties of the student in the examination of the German characters, and to point out to him what seems to us to be the easiest methods of proceeding to acquire a ready and fluent practical power over the current hand employed in Germany in social intercourse, counting-house, and college. We exhibit in our Plate the capitals and the small letters in alphabetical order. But we believe that the student who would really attain such proficiency in penmanship as would make him master of German script-craft will find it advisable to make use of the following hints:—(1) Get a neatly-ruled oblong copybook, so ruled as at least to indicate the normal height of minuscular letters—which may be made at first pretty large and distinct—and, using in the earlier exercises a well-pointed hard black pencil, proceed to work, (2) by carefully filling a page of script copy of each letter, as it has been analyzed in the foregoing paragraph, till the whole has been successfully gone through; (3) by diligently repeating the reproduction of these letters in classes, according to their likeness of form; (4) by copying the whole of the alphabet in its regular order; and (5) by proceeding in the same manner with the script capitals as analyzed and arranged in groups, and thereafter in formal order—including, of course, all double vowels and consonants. This preliminary, hand-disciplining training having been earnestly and honestly pursued, use the skill now gained to secure familiarity with the language and readiness of spelling the words most frequently met with, by (1) transcribing the lessons and performing the exercises prescribed in our German course, and then reproducing them from memory in a written form. Nothing will better fix and establish a real knowledge of the language, and added utility will accrue, if the student carefully and distinctly spells and pronounces aloud and consciously the words as he writes them. On being read *seriatim* this seems as if a tedious task were being laid upon the learner. It will not in practice be found to be so; but the interest felt in the progress made will quicken attention, stimulate to perseverance, and insure success. If thoroughly resolved to encounter with patience and earnestness the plan set before him difficulties will disappear, facility will be acquired by practice, and the pleasure of having added fresh skill to the hand, new power to the mind, and a wider capacity for usefulness and activity will crown the student's labour with the joy of victory.

NATURAL PHILOSOPHY.—CHAPTER XXVIII.

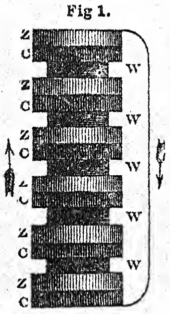
VOLTAIC OR CURRENT ELECTRICITY.

VOLTA'S PILE—THEORY OF THE PILE—VOLTAIC CURRENT AND BATTERIES—TENSION—OHM'S LAW—UNITS OF ELECTRICAL MEASUREMENT—JOULE'S LAW—VOLTAIC CIRCUIT—CHEMICAL ACTION IN THE CELL—LOCAL ACTION—AMALGAMATION—POLARIZATION—LAWS OF CHEMICAL ACTION IN A CELL—QUALIFICATIONS OF A BATTERY—BATTERIES—SINGLE-FLUID—TWO-FLUID—DRY PILE—EFFECT OF HEAT ON BATTERIES—DIFFERENCE OF POTENTIAL BETWEEN CURRENT AND STATIC ELECTRICITY—MAGNETIC EFFECTS OF ELECTRICITY—ŒRSTED'S DISCOVERY—GALVANOMETERS—ASTATIC COMBINATION—OHM'S LAW APPLIED TO THE POTENTIAL OF BATTERIES—CHEMICAL ACTION OF THE CURRENT—VOLTAMETERS—ELECTROLYSIS—QUANTITATIVE LAWS OF ELECTROLYSIS—ELECTRO-CHEMICAL EQUIVALENTS—THEORY OF ELECTROLYSIS—COMPARISON BETWEEN VOLTAMETERS AND GALVANOMETERS.

GALVANI, a professor of anatomy at Bologna, made the experiment which led to the discovery of dynamical electricity about the year 1786. Engaged in various investigations on

the influence of electricity on the nervous excitability of animals, he observed the convulsive motions produced by electric discharges from a frictional machine upon the leg of a dead frog. He accidentally discovered that when he connected the lumbar nerves with the crural muscles of the leg by a metallic circuit, consisting of a copper wire and an iron railing, a sudden kick took place. He attributed the motion to an electricity generated by the frog itself, and judged that this electricity passed from the nerves to the muscles by the metallic circuit. This view was generally received for a time, until Volta, professor of physics in the University of Pavia, demonstrated that the movement was not due to any electricity of the muscle or nerve, but to an entirely different cause—namely, the contact of the dissimilar metals. Thus, while Galvani occupied his attention exclusively with the action of the nerves and muscles of the frog, Volta directed his experiments to determine the action of the metallic circuits connecting the muscles and nerves; and observing that the contraction of the muscles was most pronounced when the metallic conductor was composed of two dissimilar metals, he attributed the phenomenon to the metals, stating that the generation of electricity was due to their contact, and that the nerves and muscles only acted as conductors for the current. It was therefore reserved for Volta to lay the foundation of the science of dynamical electricity, a term which has now almost disappeared, as that which is called statical electricity can be converted into dynamical and *vice versâ*. The contact theory which Volta propounded to explain the action of his pile, namely, that when two dissimilar substances are placed in contact, one of them always assumes the + and the other the − electricities, was speedily disputed, especially by Fabroni, who, observing that the discs of zinc employed in the pile became oxidized in contact with the acidulated water used to moisten the cloth, attributed the disengagement of electricity to chemical action. In England this new theory was supported by Wollaston and Davy. The pile as constructed by Volta consisted of a series, c z, of copper and zinc discs (fig. 1), arranged one above another in the form of a column, with moistened flannel, w, or pasteboard placed between each pair. Such a series of thirty or forty alternate discs, about 3 inches in diameter, will diverge a gold leaf electroscope, the zinc end with + and the copper with − electricity, and a slight shock will be felt on touching the extreme discs with the fingers when moistened with water. The quantity of electricity set in motion by the pile is greatly increased if the flannel or pasteboard is moistened with a solution of salt and water or slightly acidulated water, while its intensity remains nearly the same; for when a single pair of the discs are placed in contact, one becomes electrically + and the other − to a certain limited extent, that is, there is a difference of electrical potential between them; but when a number are set up with moist conductors between them, the difference of potential between the first zinc and the last copper is increased in proportion to the number of pairs of plates, as all the successive small differences of potential are added together.

Fig 1.

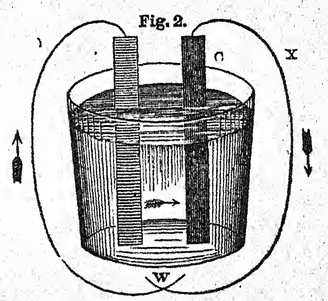


Numerous experiments on various chemical actions show that they are always accompanied by a disturbance of the electric equilibrium, though of all chemical actions those between metals and liquids are the most energetic sources of electricity, and the resultant effects follow a general law, that when a liquid acts chemically on a metal the liquid assumes the + and the metal the − condition. Frequently the electricity accompanying chemical actions is very feeble, and only rendered apparent by the indications of very delicate electroscopes. For instance, the energetic action of sulphuric acid upon zinc evolves no more free electricity than water alone does in contact with zinc. Although the theory of the chemical origin of voltaic electricity was supported by Faraday's experiments, the more recent investigations of Sir William Thomson seem to deduce conclusions in favour of the contact theory, and that the movement of electricity in the voltaic circuit is entirely due to the electric difference of potential produced at the surfaces of contact of the dissimilar metals, and these results have been further confirmed by Clifton. Notwithstanding this, it may still be regarded as probable that the chemical action between the metals and the liquids of a cell contributes, at least in some cases, to the production of the current.

Whatever may be the exact nature of electricity, it is now recognized chiefly as a medium for the transmission of force, or more properly of kinetic energy. The distinction between static electricity and current electricity is similar to that between air at rest and air in motion. When the air is calm and very still, the fact is commonly expressed by saying there is no air, although as much air is present as when it is in violent motion in the form of wind. Air when in motion exercises considerable pressure upon any body which opposes itself to its motion. Electricity at rest escapes observation; but when, owing to a *difference of potential* between two bodies in connection, it is set in motion, it produces the phenomena of light, heat, magnetic and chemical action, &c. The motion of electricity, or the electric current, may be produced in various ways, and the apparatus devised for this purpose forms three distinct groups, according to the nature of the means employed: First, apparatus in which chemical action is employed, and which directly transforms chemical affinity into electricity, such as *voltaic piles* and *voltaic batteries;* second, apparatus which directly transforms heat into electricity, such as *thermo-electric batteries;* third, apparatus which directly transforms work into electricity, such as *electric generators*, which may be subdivided into magneto-electric and dynamo-electric machines. On the chemical hypothesis a voltaic battery may be compared to a source of heat, as a furnace, which produces by the chemical combination of the coal with the oxygen of the atmosphere during the process of combustion heat to a certain temperature, and the raising of a certain volume of steam to a certain pressure. In the battery the zinc is the fuel, the liquid is the agent producing combustion by which the electric current is generated, having a certain tension or electro-motive force, and a certain intensity, as steam has a distinct pressure and volume.

The simplest form of battery is that with a single liquid, one element of which will consist of the vessel containing the acting materials; the zinc forming the − pole of the battery; the liquid, dilute sulphuric acid; and a plate not attacked by the liquid, such as carbon or copper, which forms the + pole on receiving the electricity from the liquid by conduction. Fig. 2 represents a simple element; the zinc plate, z, forms the − pole of the battery; the liquid is one part sulphuric acid with ten parts water; the copper plate, c, receives by conduction the polarity of the liquid to form the + pole. On connecting the two plates by conducting wires, x, y, and joining the wires as at w, the electricity circulates as a continuous current through the wire in the direction indicated by the arrows. When the zinc plate comes in contact with the liquid a difference of electric tension is produced between them, which is called the *electro-motive force* of the element. This tension, or *difference of potential* between the zinc and copper poles, is analogous to the pressure which causes water to flow through a conducting pipe, and the intensity of the current in the circuit may be considered as represented by the volume of water delivered by the pipe, the conducting wire representing the water-pipe. The wire offers a resistance to the electric current as the pipe offers a resistance by friction to the passage of the water. The electric current circulating in the outside conductor is therefore influenced by three distinct elements:—

Fig. 2.



1. The difference of potential or tension, the cause by which the electric current is set up, and of which electro-motive force is the effect.

2. The volume or intensity of the current, or the quantity of electricity traversing any section of the circuit in a unit of time.

3. The resistance of the circuit, or the resistance which the conductor, taking into consideration its dimensions and nature, opposes to the circulation of the current.

The law which connects the resistance of the conductor, the electro-motive force, and the intensity of an electric current, has been established by Ohm, and is expressed as follows:—The intensity $= \frac{\text{electro-motive force}}{\text{resistance of the current}}$, or $I = \frac{E}{R}$; therefore the intensity of a current in an electric circuit is in direct proportion to the electro-motive force, and in inverse proportion to the resistance. To measure the elements of an electric current, the difference of potential, intensity, and resistance, certain units are adopted.

The unit of resistance is termed the *ohm*, which is equal to the resistance of an iron wire 4 millimètres diameter and 100 mètres in length, or a wire of pure copper 1 millimètre in diameter and 48·64 mètres long.

The unit of electro-motive force is the *volt*, and corresponds nearly to the electro-motive force generated by one Daniell's element, the exact value in volts being 1·079.

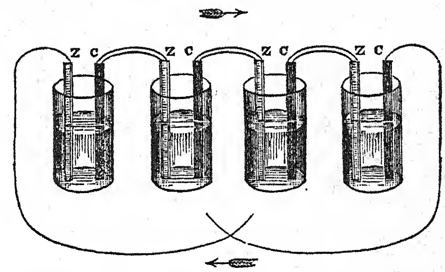
The unit of intensity is defined by Ohm's formula $I = \frac{E}{R}$, and takes the name of the *ampère*. It is the intensity of current of the electro-motive force of one *volt* which traverses a conductor, whose resistance is one *ohm*.

The unit of quantity is the *coulomb*, and represents the quantity of electricity which traverses, during one second, a conductor of one ohm resistance and a difference of potential of one volt. A current with the intensity of one ampère gives per second a quantity of electricity equal to one coulomb. A current with an intensity of one-hundredth ampère will give a quantity of electricity equal to one coulomb in 100 seconds.

The *farad* is the unit of capacity, and represents the capacity of a condenser which contains one coulomb of electricity when charged to the potential of one volt. The quantity of electricity contained in a condenser is proportional to the electro-motive force. In order to express multiples and submultiples, the prefixes *mega* and *micro* are used respectively. A *megohm* is the resistance of 1,000,000 ohms; a *microfarad* is the capacity of 1-1,000,000th part of a farad, and is the practical unit of capacity, the farad being too large for ordinary use. A Leyden jar with a total coated surface of a square metre and a glass 1 mm. thick, has a capacity of one fifty-fifth of a microfarad. A milleampère is the thousandth part of an ampère. The five electrical quantities are therefore expressed in corresponding units—electro-motive force in volts, resistance of conductor in ohms, intensity of the current in ampères, quantity of electricity in coulombs, capacity of a condenser in microfarads. The law discovered by Joule—that the quantity of heat or work W, developed by an electric circuit is proportional to the square of the intensity of the current I, to the resistance of the circuit R, and to the time t—is expressed by the formula $W = I^2Rt$. On replacing R by its value taken from Ohm's formula, $W = IE$, so that the work is proportional to the intensity of the electric current and the electro-motive force.

When a number of simple cells are united in series (fig. 3), the zinc plate of one being joined to the copper of the next, and so on, a greater difference of potential will be produced between the copper plate or pole at one end of the series and the zinc pole at the other end, so that when the two poles are joined by a wire there will be a more powerful flow of electricity than one cell would cause. Such a combination of voltaic cells is termed a voltaic battery; and by Volta's laws, the total electro-motive force of the series will be equal to the electro-motive force of one cell multiplied by the number of cells; and that battery will give the greatest electro-motive force in which the materials used give the greatest difference of potentials on contact, or which are widest separated in the contact series. The same electro-motive force does not, however, always produce a current of the same strength. The strength of the current depends not only on the force tending to circulate the electricity round the circuit, but also on the resistance which it has to encounter

Fig. 3.



and overcome in its flow. Thus, if the cells be partly filled with sand or sawdust, or if the wire composing the circuit be very long or of a very small diameter, the action will be greatly impeded, and the current be weaker although the electro-motive force may be the same. The liquids in the battery are never such good conductors as the metals, and different liquids have different resistances. For the feeble electricity of the voltaic battery pure water is almost an insulator, although for the high potential electricity of the frictional machine it is a good conductor.

A current of electricity produced by a voltaic cell is always accompanied by chemical actions in the cell, as one of the metals must be readily oxidizable, and the liquid must be one capable of acting on the metal. Thus zinc and the other metals which stand at the electro-positive end of the contact series are oxidizable; copper, silver, gold, platinum, and graphite are electro-negative and less oxidizable, and the last three resist the action of every single acid. Perfectly pure zinc, when dipped alone into dilute sulphuric acid, is not attacked by the liquid; but ordinary commercial zinc, being very impure, is dissolved away by the acid, a large quantity of bubbles of hydrogen gas being thrown off from the surface of the metal. Sulphuric acid is a compound substance, in which every molecule is composed of a group of atoms—2 of hydrogen, 1 of sulphur, and 4 of oxygen; the symbols for which are, H_2SO_4. The following equation expresses the chemical reaction by which the zinc enters into combination with the radical of the acid, liberating the hydrogen:—

Zinc and sulphuric acid	produce	sulphate of zinc and hydrogen.
$Zn + H_2SO_4$	$=$	$ZnSO_4 + H_2$.

The sulphate of zinc produced in this reaction remains in solution in the liquid. When a plate of pure zinc and one of copper or carbon are placed side by side into a cell containing acid, no appreciable chemical action results until the circuit is closed by joining the two plates with a wire. So soon as the circuit is completed a current flows and chemical action is set up, the zinc dissolving in the acid and the acid giving up its hydrogen in streams of bubbles. The bubbles of hydrogen are in this case evolved at the surface of the copper plate, and not at the zinc plate, and these chemical actions continue so long as the current passes. The amount of zinc dissolved in each cell is proportional to the amount of electricity which flows through the circuit, or to the strength of the current. The quantity of hydrogen gas evolved is also proportional to the quantity of zinc consumed, and also to the strength of the current. After the acid has dissolved a certain quantity of zinc it will no longer act as a corrosive solvent, having been neutralized and converted into sulphate of zinc, and then the battery ceases to act. When the battery circuit is not closed the current cannot flow, and properly speaking there should be no chemical action. Owing, however, to the impurities of commercial zinc, which contains particles of iron, arsenic, and other metals, it does not remain quiescent in the acid, but is continually wasting away and giving off hydrogen bubbles. This local action between the particles of iron and the zinc particles in the

immediate neighbourhood causes a local difference of potential to be set up at the point where there is metallic contact, and a local current to run from the particles of zinc through the acid to the particles of iron, which produces a constant waste of the zinc when the battery circuit is open. In order to suspend this local action the surface of the zinc plates is rubbed over or amalgamated with mercury. The mercury unites with the zinc at the surface, forming an amalgam. The iron particles in the zinc do not dissolve in the mercury, but remain on the surface, the hydrogen bubbles, which form speedily, carrying them off. As the zinc in this amalgam dissolves into the acid the film of mercury unites with fresh portions of zinc, and the plate always presents a bright surface to the liquid.

The bubbles of hydrogen gas liberated at the surface of the copper plate are found to adhere to it in great numbers, and to form a film over its surface, by which the effective surface of the copper plate is seriously reduced in a short time; and the reduction of the strength of the current from a battery which has been a short time in action is almost entirely due to this film of hydrogen adhering to the surface of the copper. A battery in this condition is said to be polarized. The effect of polarization is twofold: it weakens the current by the increased resistance offered to the flow, as bubbles of gas are bad conductors; and also by setting up an opposing electro-motive force, for hydrogen is nearly as oxidizable a substance as zinc, especially when freshly deposited or in a nascent state, and it is besides electro-positive, so that the hydrogen itself produces a difference of potential, tending to start a current in the opposite direction to that from the zinc to the copper. Various plans, mechanical, chemical, and electro-chemical, are employed to reduce or prevent the polarization of the cells. The mechanical means employed are the agitation of the liquid, or its constant circulation by means of siphons; the blowing of air into the liquid through a tube, or the roughening the surface of the plate, as bubbles collect more freely at the points and are quickly carried up to the surface. This plan has been applied to the Smee's cell, the silver plate having its surface covered with a rough coating of finely divided platinum, which gives up the bubbles freely. The chemical means employed consist in adding to the acid a substance capable of combining with the hydrogen while in the nascent state. Such substances are nitric acid, bichromate of potash, and bleaching powder (chloride of lime), but as they would attack the copper they can only be employed in zinc-carbon or zinc-platinum cells. Nitric acid, which attacks zinc when the circuit is open, cannot therefore be employed in the same cell with the zinc plate. In electro-chemical arrangements double cells are employed, and are so arranged that some solid metal, such as copper, shall be liberated at the point where the current leaves the liquid, in place of hydrogen bubbles. This electro-chemical exchange entirely overcomes polarization.

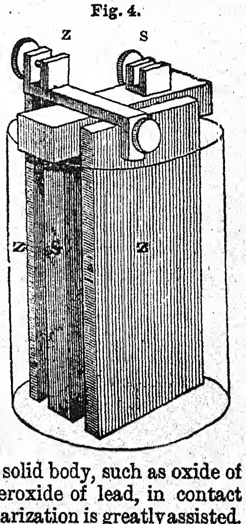
The laws of chemical action in the cell are:—That the amount of chemical action in the cell is proportional to the quantity of electricity that passes through it—that is, to the strength of the current while it passes; and that the amount of chemical action is equal in each cell of a battery, consisting of cells joined *in series*, with the positive plate of one connected with the negative plate of the next cell, as in fig. 3.

From what has been already stated it is evident that a good voltaic battery should fulfil more or less the following conditions:—The electro-motive force should be high and constant; the internal resistance should be a minimum; the current should be constant and free from the effects of polarization, not rapidly exhausted nor requiring frequent re-charging with liquid; it should be free from local action when the circuit is open; it should be durable and inexpensive in construction; it should be easily recharged and free from corrosive fumes. No single battery yet invented fulfils all these conditions, though some batteries fulfil them better than others, and some batteries are more suited for one purpose than for another. For instance, considerable internal resistance is no serious disadvantage in the battery when it is employed for telegraphing through long circuits; while great internal resistance in the battery would be absolutely fatal to the production of the electric light. As the electro-motive force of a battery depends on the materials of the cell and on the number of cells joined together in series, a high electro-motive force may be obtained by selecting the proper substances and employing a large number of cells. The resistance within the cell may be reduced by employing larger plates and bringing them closer together, and by selecting liquids that are good conductors.

Batteries may be divided into two classes—those in which a single liquid is employed, and those which contain two liquids or electrolytes. The simple cell of Volta, with its zinc and copper plates, has suggested the construction of innumerable single-liquid batteries. In Cruickshank's battery the plates are placed vertically in a trough. In Wollaston's battery, the plate of copper is of double size, bent round so as to be opposed to both sides of the zinc, thus diminishing the resistance, and the series of plates are so arranged on a cross frame of wood that they can be raised out of the liquid when the battery is not in action. In other single-fluid batteries copper has been replaced by electrodes of other substances. Walker in 1849 used plates of hard carbon instead of copper, increasing the electro-motive force and reducing the cost, and in 1857 platinized the carbon, in which form the single-liquid battery is still extensively used for railway signal service. Again, the negative electrode or positive pole of the single-liquid battery is now generally coated with substances which facilitate the discharge of hydrogen or its combination with oxygen to form water. The simple bichromate of potash cell is almost the only single-fluid cell free from polarization, although the strength of the current is reduced after a few minutes action, owing to the chemical reduction of the liquid. It consists of a zinc plate attached to a brass rod, which slides up and down in a tube in an ebonite or porcelain cover, so as to be more or less immersed in the liquid. Two carbon plates are fitted to the cover, and by means of strips of brass the carbon and the zinc plates are respectively in connection with the terminal screws, which form the poles of the battery. The solution consists of bichromate of potash, 200 grammes; sulphuric acid, 150 to 200 grammes; water, 2 litres. It is advisable to add 5 grammes of bisulphate of mercury to keep the zinc well amalgamated. The electro-motive force is 1·8 or 1·9 that of a Daniell. When the element is closed by a wire of small resistance its electro-motive force increases slightly at first, then remains constant for some time, after which it sinks to half its original amount.

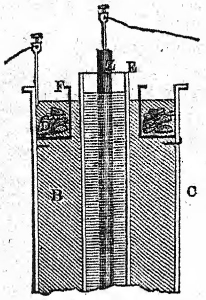
In Smee's battery (fig. 4) the depolarization of the − plate is accomplished by mechanical means. Each element consists of a sheet of platinum placed between plates of zinc, z z, the liquid being dilute sulphuric acid in the proportion of one part acid to seven parts water. The adherence of hydrogen to the negative plate is prevented by the platinum being coated with a deposit of finely-divided platinum, roughening the surface. Silver similarly coated is frequently used in place of platinum, as being less costly. The electro-motive force is considerably less than in the Daniell, and the battery may be kept in active operation for eight or ten days, when a sufficiency of acid is supplied. It is extensively used in the art of electro-metallurgy. Single-fluid batteries, with the exceptions named, have been replaced by batteries with two fluids, or by cells in which, in addition to the one fluid, there is a solid body, such as oxide of copper, oxide of manganese, or peroxide of lead, in contact with the carbon pole, by which depolarization is greatly assisted. Such batteries are termed constant, because their action continues for a considerable period of time without material alteration. The use of copper sulphate, or nitrate, was first proposed by Becquerel in 1829 with very satisfactory results. The first form of the constant battery was invented by

Fig. 4.



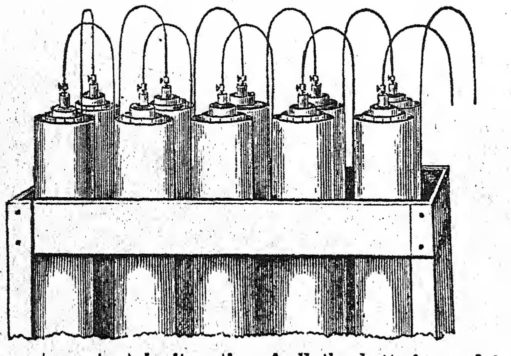
Daniell in 1836, and differed from Becquerel's in the nature of the porous cell, which, in the Daniell, was originally of gold-beater's skin, and in Becquerel's of kaolin. The Daniell cell in its present form (fig. 5) consists of a cylinder of copper, C, containing a cell, E, of porous unglazed biscuit ware, which has a solid rod of zinc, Z, supported in its centre; the cylinder is furnished with a perforated shelf, F, at the top of the cell, upon which a supply of crystals of sulphate of copper is placed, in order that they may dissolve and replace that which is used up. The copper cell contains a mixture of eight parts water and one of sulphuric acid, which has been saturated with sulphate of copper. The porous cell is filled with the same acid mixture without the copper sulphate.

Fig. 5.



A set of ten large cells is shown in fig. 6 connected in *series*, the copper cylinders being 18 inches high, with zinc rods and porous cells in proportion. This forms a powerful voltaic arrangement, evolving 8 or 10 cubic inches of oxygen and hydrogen gases in a voltameter per minute, and heating to redness 12 or 14 inches of fine iron wire. It is

Fig. 6.



the most constant in its action of all the batteries, and its electro-motive force is 1·12 volt. From its constancy this battery, made up in a convenient form, is used by the thousand in the telegraphic service. When the circuit of the battery is closed the zinc dissolves in the dilute acid in the porous cell, forming sulphate of zinc, and liberates the hydrogen, which traverses the pores of the cell into the outer cell, where, in the sulphate of copper solution, the hydrogen atoms are exchanged for copper atoms, the result being a deposit of pure copper upon the outer copper plate. Chemically these actions may be regarded as taking place in two stages.

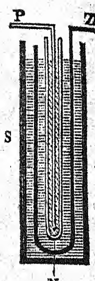
Zinc and sulphuric acid produce sulphate of zinc and hydrogen ($Zn + H_2SO_4 = ZnSO_4 + H_2$), and hydrogen and sulphate of copper produce sulphuric acid and copper ($H_2 + CuSO_4 = H_2SO_4 + Cu$). Thus the hydrogen is electro-chemically exchanged for copper, and while the zinc dissolves away the copper increases, the dilute acid changing gradually into sulphate of zinc, and the sulphate of copper into sulphuric acid. No polarization therefore takes place so long as the copper solution remains saturated.

Trouvé's moist battery is a Daniell's battery in principle, acting without a liquid. This form of battery consists of a round zinc disc and a copper disc placed parallel to one another, and separated by a pile of paper discs of rather smaller dimensions. The lower half of the mass of paper discs is soaked in a saturated solution of sulphate of copper, the other half in a solution of sulphate of zinc.

The great advantage of this new arrangement is the almost complete suspension of the interior work of the battery when the circuit is open, as the liquids cannot easily mix owing to their different densities.

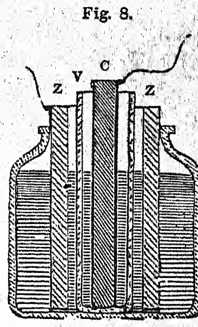
Sir William Grove has devised a form of battery having both greater electro-motive force and smaller internal resistance than the Daniell cell, and in which the copper sulphate solution gives place to nitric acid, and the copper to platinum. The construction of this battery is shown in section, fig. 7. Each element consists of a cell of glazed earthenware or of ebonite, S, containing the amalgamated zinc plate Z, which is bent round to present surfaces to both sides of the inner porous cell N, which contains a piece of platinum foil as the − pole. The solution in the outer cell containing the zinc is dilute sulphuric acid, one of water to four of acid. The inner porous cell contains the strongest nitric acid. The platinum plate P, of each porous cell is connected with the zinc of the next cell by a binding screw. In this arrangement there is no polarization, as the hydrogen liberated by the action of the dilute acid upon the zinc, in passing through the nitric acid to reach the platinum pole, decomposes the nitric acid and is itself oxidized, producing water and liberating nitric peroxide gas. As this gas is soluble in nitric acid, it does not form a film upon the surface of the platinum plate, and no polarization takes place, neither does it, like hydrogen, set up an opposing electro-motive force with the zinc. A Grove cell, from its small internal resistance, owing to the good conducting power of the nitric acid, will furnish for three or four hours continuously a powerful current. Th electro-motive force of a cell is about 1·9 volt. Fifty Gro cells, holding about a quart of liquid, produce a current sufficient power to develop a brilliant electric light betwe carbon points.

Fig. 7.



The Bunsen battery (fig. 8) is a modification of that Grove, and is known as the zinc-carbon battery, the expe sive platinum plate being replaced by a rod or slab of ha gas carbon, C, contained in the porous cell V, and surrounded by the zinc plate Z. The difference of potential in the zinc-carbon combination is slightly higher than in the zinc-platinum arrangement. The chemical action of the Bunsen battery is the same as that of the Grove, and being equally powerful, while less costly, it is in general use on the Continent. It is not, however, so convenient to manipulate, owing to the difficulty of maintaining a good contact between the rough surface of the carbon and the copper connection with the zinc of the next cell; it is besides more expensive to work. The battery has an electro-motive force of 1·9 volt.

Fig. 8.



Warren De la Rue has constructed a cell which is perfectly constant. Zinc and silver are the two metals. The zinc is immersed in a solution of chloride of ammonium, and the silver is embedded in a stick of fused chloride of silver. The outer jar is 13 centimètres long and 3 centimètres in diameter. The zinc rod is not amalgamated. The liquid is a solution of 23 grammes of chloride of ammonia in one litre of water. The hydrogen evolved at the negative plate reduces the silver chloride to metallic silver, which is deposited as a porous substance, first on the surface and afterwards gradually in the mass of the chloride of silver. This battery has no local action so long as the circuit remains open, and although a single-liquid arrangement, it will be seen that the acting agent, the chloride of silver, is a solid body, which is not dissolved in the liquid with which it is in contact, but supplies the chlorine necessary for the solution of the zinc. The electro-motive force is between 1 and 1·07 volt. The interior resistance depends upon the time of action and the size of the elements.

A standard cell, the electro-motive force of which is more constant than the Daniell cell, has been arranged by Latimer Clark. The element consists of pure mercury, on which floats a paste obtained by boiling sulphate of mercury in a saturated solution of zinc sulphate. The + metal is a plate of zinc resting on this paste of sulphate. Insulated wires from the mercury and the zinc form the connections. This battery furnishes a standard of electro-motive force which is

constant and reliable, although the battery itself is not adapted for continuous work. The electro-motive force is 1·436 volt. The following numbers represent the electro-motive force of some of the elements most frequently used:—

Single-fluid Cells.	Electro-motive force in Volts.
Volta, Wollaston,	1·036 – 0·81
Smee,	0·64 (doubtful)
Trouvé,	2·27 – 1·77
Two-fluid Cells.	
Daniell,	1·122
Grove,	1·934 – 1·76
Bunsen,	1·942 – 1·73
Leclanché,	1·59 – 1·46
Niaudet,	1·63
De la Rue,	1·046
Marié Davy,	1·50
Latimer Clark's standard,	1·436
Bichromate of potash,	1·9

Zamboni's "dry pile" consists of a number of paper discs, coated with zincfoil on one side and with binoxide of manganese on the other, piled upon one another, to the number of some thousands, in a glass tube, which is provided with a brass cap at each end. Each cap has a rod and knob by which the leaves can be pressed together so as to produce more perfect contact. The knob in contact with the manganese is the + pole, the zinc end is the – pole. Dry piles are remarkable for the permanence of their activity, which continues for years. The internal resistance is very great, as the moisture of the paper is very slight. The electro-motive force is, however, very great, and a properly constructed pile will yield sparks. At Oxford in the Clarendon Laboratory a dry pile, the poles of which are two metal bells, between which is suspended a small brass ball, has been continuously discharging itself by the oscillation to and fro of the ball for over forty years. The action of the pile is stronger in summer than in winter, and the action of a strong heat will revive a pile even when it appears to be exhausted. In the same way heat produces a stronger current from a cell than cold. This is due to the liquids being better conductors when warm, the internal resistance being then lessened. The electro-motive force is also increased by heat. In a Daniell cell it is $1\frac{1}{2}$ per cent. higher when raised to 100° C. In the bichromate battery heat has an opposite effect, the electro-motive force being at a temperature of 100° C. nearly 2 per cent. less.

In all the batteries described the available work in the external circuit depends upon the number of calories produced by the combination of zinc with the acting liquid, so that a battery which may render valuable services in telegraphy and for laboratory experiments is unable to supply large quantities of electricity. Zinc costs fifteen times as much, weight for weight, as coal, and generates five times less heat, consequently batteries are not used for electric lighting. The battery is employed to advantage in work where electricity is required more for the rapidity and delicacy of its action than for its efficiency. Thus it is almost exclusively applied to the production of electricity for telegraphy and telephony.

The difference of potential between the poles, except in the case of batteries consisting of a very large number of cells, is greatly below that of the frictional electric machine, and is generally insufficient to produce any visible spark. In the case of a single cell or a small battery a very delicate test is required to detect any signs of free electricity. By using a very delicate condensing electroscope, carefully insulated, it can be shown that the two poles of the battery possess + and – charges. By quantitative measurements Nystrom has shown that the potential of the charge of the plate of an ordinary electrophorus is 50,000 times greater than the potential of a Meidinger's element. In other words, to produce the same potential as that of the electrophorus, 50,000 such cells would be required supposing the insulation good; but in practice, from the impossibility of obtaining good insulations, the number would be much greater.

MAGNETIC EFFECTS OF ELECTRICITY—ŒRSTED'S DISCOVERY.

The disturbing effect produced on the magnetic needle by lightning and the aurora borealis had long suggested that the agencies of electricity and magnetism were closely connected, and various theories were started to account for the phenomena. Magnetic properties could be communicated to steel bars by passing a shock of electricity through them, but no general law could be deduced as governing the polarity imparted. In 1774 Van Swinden, of Franeker, arrived at the conclusion that the similarity between electricity and magnetism was merely an apparent resemblance, and did not constitute a true physical analogy, and that the two forces were different and distinct. Steiglehner and Hubner again maintained that both classes of phenomena were referable to the same agent, varying only in consequence of a diversity of circumstances. Thus the subject remained for some years after the discoveries of Galvani and Volta, which opened up the means of producing large and continuous currents of electricity. Ritter was the first who approached a solution of the question. He found that a needle composed of silver and zinc arranged itself in the magnetic meridian, and was slightly attracted and repelled by the poles of a magnet; and that by placing a gold coin in the voltaic circuit it acquired + and – poles, and that the polarity so communicated was retained by the gold after it had been in contact with other metals, and therefore partook of the nature of magnetism. A gold needle, under similar circumstances, acquired still more decided magnetic properties, and a metallic wire, after being exposed to a voltaic current, took a direction north-east and south-west. The theories of Ritter were, however, so vague that they excited no attention, and no satisfactory results were obtained until Œrsted, of Copenhagen, in 1819 made his famous discovery, which forms the basis of the science of electro-magnetism. Œrsted found that a magnetic needle, poised horizontally on a pivot, and moving freely in a horizontal plane, adjusts itself in the magnetic meridian; and that when a metallic wire is placed parallel to the needle at a short distance above it (fig. 9), and a current of electricity is passed through the wire, the magnetic needle no longer remains parallel to the wire, but at once leaves the magnetic meridian, and tends to

Fig. 9.

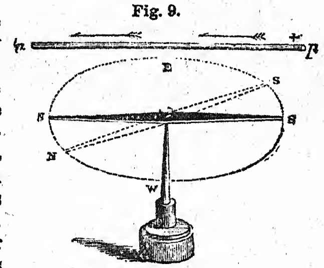
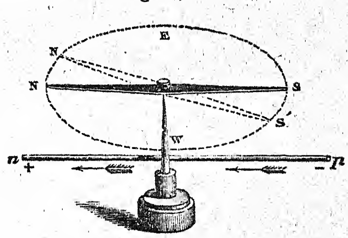


Fig. 10.

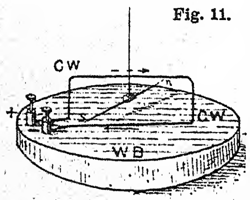


place itself across the wire at right angles to the direction of the current; and that the same effect is also produced when the wire is placed below the needle (fig. 10), except that the same end of the needle takes a contrary direction. Also, that if the direction of the current passing through the wire, as in fig. 9, is towards the end of the needle marked N, that end will be deflected in an opposite direction when the current passes through the wire in the direction of the S pole. Ampère, who employed the magnetic needle, the coil of wire, and the voltaic current in 1820, to transmit signals by the motion of the needle, suggested the following simple rule by which to keep these movements clearly in memory:—If the observer considers himself to be the conducting wire *n p*, placed parallel to the needle, and that his face in every position is turned towards the centre of the needle, and that the current from the + end of the battery enters at his feet and passes out at his head, then the current will be found to cause the deflection of the south pole of the needle towards his right, and of the north pole towards his left hand. When the direction of the current is reversed the deflection of the same

pole of the needle is also reversed; consequently, in the directive action of currents on magnets, the north or marked pole of the needle is always deflected towards the left of the direction in which the current flows.

In these experiments the magnetic needle will not assume a position exactly at right angles to the direction of the current, but take an oblique position, on account of the influence of the earth's magnetism, which tends at the same time, in opposition to the directive influence of the current, to make it point north and south. The resultant between these two forces is therefore an oblique direction, which will depend for its angular value upon the relative strength of the two opposing forces. When the current is very powerful the needle turns at a large angle; but if the current is feeble in comparison with the directive force of the earth's magnetism, the angle of deflection is small. This arrangement therefore becomes a *galvanoscope* and a *galvanometer*, or an indicator of the direction of a current, and also a measurer, by the angle of deflection, whether the current is one of high or low potential energy. In the simplest form of the apparatus, however, it is unable to detect very delicate currents, or to measure small differences of potential. A more sensitive arrangement is obtained either by increasing the effective action of the current or the number of turns of the wire round the needle, or by neutralizing the directive influence of the earth's magnetism upon the needle by some compensative arrangement.

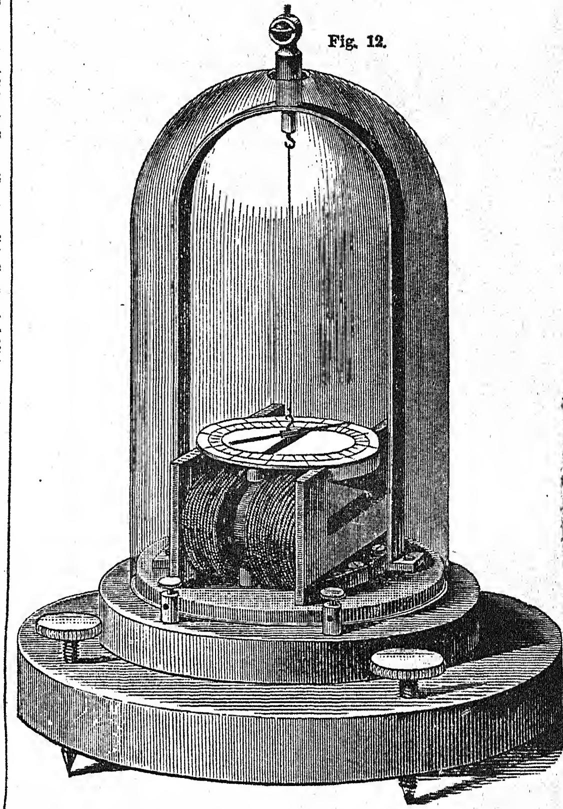
Fig. 11.



The principle of the galvanometer will be understood by supposing a magnetic needle, *n s* (fig. 11), to be suspended by a filament of silk in the plane of the magnetic meridian, and surrounded by a copper wire, C W, forming a complete circuit round the needle in the direction of its length. When this wire, C W, is traversed by a current, the directive force of the current in every part will tend to deflect the marked end, N, in the same direction, that is, the actions of the four branches of the circuit concur to produce on the marked end the same directive tendency. If, in place of only a single loop of wire, there are several turns surrounding the needle in a direction parallel to its length, the action of the current upon the needle will be augmented and the deflection of the needle increased. There is, however, a limit to the multiplication of the coils of wire surrounding the needle, as the intensity of the current diminishes with the increased length of the circuit, owing to the resistance of the conductor. In order to compensate the directive action of the earth's magnetism upon the galvanometer needle two methods are adopted. One consists in the employment of a compensating magnet laid in the magnetic meridian. At a certain distance from the needle, by adjustment, it will be found capable of neutralizing the directive force of the earth's magnetism. This form of adjustment is frequently employed in the reflecting galvanometer. The more usual method of compensation is by the employment of the *astatic needle*, which consists of two magnetized needles of equal strength and size, suspended together by a light brass wire, with their marked poles reversed; so that the force urging one to set itself in the magnetic meridian is exactly counterbalanced by the force that acts on the other. The pair of suspended needles will therefore remain in any position in which it is set, and is independent of the action of the earth's magnetism. In practice it is very difficult to obtain needles of exactly equal magnetization, and at the same time to fix them perfectly parallel to one another. An astatic pair of needles is readily deflected by a current flowing in a wire coiled around one of the needles, as the coil will pass above one needle and below the other, and therefore affect both alike, the needles being reversed in their polarity.

The *astatic galvanometer* (fig. 12), for the measurement of the strength of the current by means of the deflection of a magnetic needle, consists of an astatic pair of needles delicately suspended by a silk filament, so that the lower needle lies within a coil of silk covered wire, wound upon an ivory frame, which carries a graduated circle, with a central slit parallel to the direction in which the wire is coiled. The zero upon the scale corresponds to the position of this slit. The ends of the coil wire are brought out to two terminals for connection to the battery or circuit. In using the instrument the movable hook which supports the silk fibre is turned until the end of the needle corresponds to the zero. When a current is sent through the wire coils, the needle is deflected to the right or left over the graduated scale. If the deflections are small, some 10 or 15 degrees, they are very nearly proportional to the strength of the currents that produce them; consequently, a current giving 8 degrees will be approximately four times as strong as a current which only deflects the needle through 2 degrees. When the deflections exceed 15 degrees, only a part of the force of the coils acts upon the needle, since the poles are no longer within the coils; it is then necessary to calibrate the galvanometer—that is, to determine by comparison with a standard instrument to what strength of current particular deflections correspond. Thus, if a deflection of 35 degrees on a particular galvanometer is the result of a current of one-hundredth of an ampère, a current of that strength will always produce on the same instrument the same deflection, unless the torsion force of the fibre or the intensity of the magnetic field is altered.

Fig. 12.

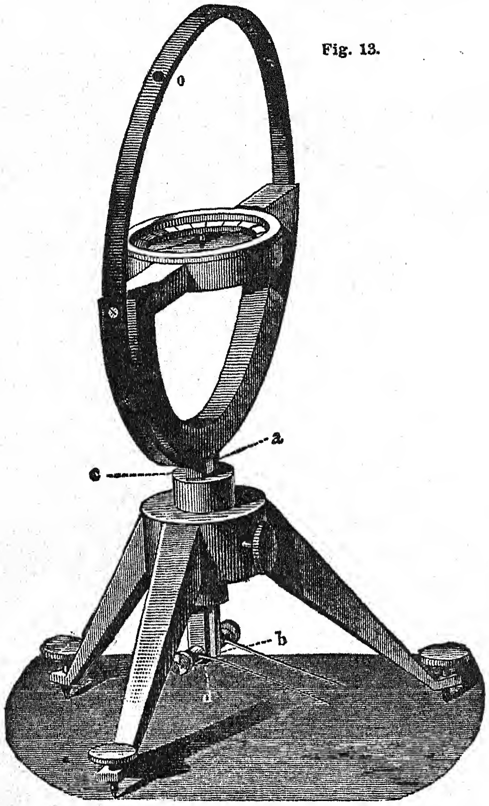


For the purpose of comparing two currents, the *differential galvanometer* is frequently employed, in which the coil consists of two separate wires of the same kind and diameter, carefully insulated from each other, wound side by side, and provided with terminal screws, so that separate currents can be passed through each of them. If two equal currents are sent in opposite directions through these wires, the needle will remain stationary. If the currents are unequal, the needle will be moved by the stronger current, with an intensity corresponding to the difference of the strength of the two currents.

The *tangent galvanometer* (fig. 13) is an instrument based upon the principle that when a magnetic needle is suspended in the centre of a voltaic current, the strength of the current is proportional to the tangent of the angle of deflection, provided the dimensions of the needle are sufficiently small as com-

pared with the diameter of the circuit, so that its poles are never far from the centre and do not extend into the regions where the magnetic force is variable. Consequently, whatever magnetic force the current in the coil exerts on the needle is always exerted normally to the plane of the ring, and at right angles to the magnetic meridian. Therefore a

Fig. 13.



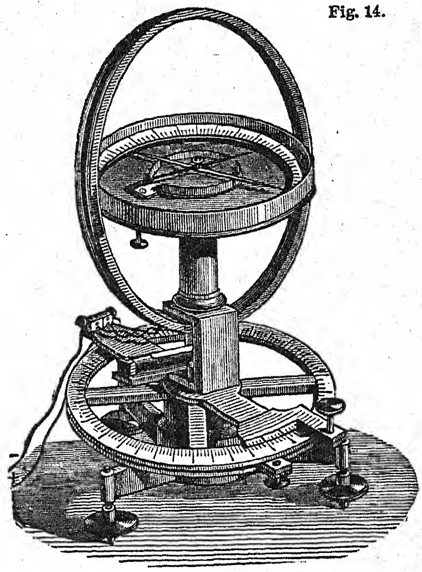
current flowing through the coil will deflect the needle through an angle, in which the tangent of the angle of deflection is proportional to the strength of the current.

The instrument consists of a copper ring *o*, 12 inches in diameter, and about an inch in breadth, mounted vertically on a stand provided with three levelling screws. The lower half of the ring is fitted in a semicircular frame of wood to keep it steady. In the centre of the ring a delicate magnetic needle is suspended, the length of which does not exceed one-tenth or one-twelfth of the diameter of the circle. Underneath the needle is a graduated scale. The ends of the ring *a*, *c*, are prolonged to the two terminals *a*, *b*, by which it can be connected with a battery or cell. The circle is placed in the plane of the magnetic meridian, and the deflection of the needle is directly read off on the scale, its corresponding value being obtained from the table of tangents.

The field due to a current passing round the circle is very uniform at and near the centre, and the lines of force are there normal to the plane of the coil. In using the tangent galvanometer, if a certain battery give 10 degrees on the galvanometer, and a second battery give 25 degrees, the strengths of the currents will be in the proportion of tan 10 to tan 25 degrees; or, if current C produces x deflection, and current C′ produces x' deflection, $C : C' :: \tan x : \tan x'$.

The *sine galvanometer* is another form of apparatus for measuring currents of high potential, and has the advantage of being more sensitive than the tangent galvanometer. Any sensitive galvanometer may be used as a sine galvanometer, provided the frame on which the coils are wound can be turned round a central axis. It consists of a circular frame (fig. 14), round which are several turns of thick insulated copper wire, the two ends of which terminate in binding screws. On a table in the centre of the coil is horizontally fixed a magnetic needle. A second light aluminium needle is fixed at right angles to the first, to serve as a pointer over the graduated scale. The coil and needle both revolve on a central axis furnished with a vernier in connection with the fixed horizontal index. In using the instrument the coils are first set parallel to the needle. On a current passing through the coils the needle is deflected. The coils are then turned until they coincide with the vertical plane passing through the needle. This angle is read off on

Fig. 14.



the lower horizontal scale. The angle of deflection, and hence its sine, being known, the strength of the current in the coil is proportional to the sine of the angle through which the coil has been turned.

TABLE OF NATURAL SINES AND TANGENTS.

Arc.	Sine.	Tangent.	
0°	0·000	0·000	90°
1	·017	·017	89
2	·035	·035	88
3	·052	·052	87
4	·070	·070	86
5	·087	·087	85
6	·105	·105	84
7	·122	·123	83
8	·139	·141	82
9	·156	·158	81
10	·174	·176	80
15	·259	·268	75
20	·342	·364	70
25	·423	·466	65
30	·500	·577	60
35	·574	·700	55
40	·643	·830	50
45	·707	1·000	45
50	·766	1·192	40
55	·819	1·428	35
60	·866	1·732	30
65	·906	2·145	25
70	·940	2·747	20
75	·966	3·732	15
80	·985	5·671	10
81	·988	6·314	9
82	·990	7·115	8
83	·993	8·144	7
84	·995	9·514	6
85	·996	11·43	5
86	·998	14·30	4
87	·999	19·08	3
88	·999	28·64	2
89	·999	57·29	1
90	1·000	Infinite	0
	Cosine.	Cotangent.	Arc.

The strength of currents which last only a very short time is measured by a *ballistic galvanometer*, in which a long and heavy needle swings slowly round. In this movement the sine of half the angle of the first swing is proportional to the quantity of electricity that has flowed through the coil. The charge of a condenser may be measured by discharging it through the instrument.

For galvanometers of exceeding delicacy the moving parts must be made both small and light. As the angular motions of a very small needle will not be easily read off by the eye, an index of some kind must be employed to register its movements. Sir W. Thomson has devised a very sensitive instrument, termed the *mirror galvanometer* (fig. 11, Plate XXV). The body of the instrument, B, containing the coil, is supported on three screw-adjustment feet. The magnet itself is made of a piece of fine watch-spring three-eighths of an inch long, weighing about a grain, and it is attached to the back of a very small and very slightly concave mirror of thin silvered glass, not larger than a threepenny piece. The mirror is hung within the coil, shown in section in fig. 12, by a single fibre of cocoon silk. A curved magnet, E, which is employed to counteract the earth's magnetism or to direct the needle, is carried upon a vertical support attached to the body of the instrument. This adjusting magnet is capable of being turned in any direction, and may also be advanced or removed further from the coil, according as it is slid up or down the rod. The small magnet is therefore capable of very delicate adjustment. Opposite the galvanometer, at a distance of about 3 feet, is placed a scale with the zero in the centre and the graduations extending on each side. A beam of light, R, from a paraffin lamp situated behind the scale, passes through a narrow slit under the zero of the scale, and falls on the mirror, which reflects it back in the direction R′ on to the scale in the form of a well-defined spot of light if the scale is adjusted to suit the focus of the mirror. The adjusting magnet, E, enables the reflected spot of light to be brought to the zero point at the middle of the scale. The feeblest current passing through the coil will cause the spot of light to deflect to the right or left. The infinitesimal current produced by dipping the points of a brass pin and a steel needle into a drop of salt water will send the spot of light flying right across the scale. For more delicate work a pair of astatic needles is used, each being surrounded by its coil, the mirror being attached to one of the needles. In using such sensitive galvanometers care must be taken not to pass strong currents through them, for even if they are not destroyed the deflections of the needle will be too large to afford accurate measurements. In order to modify the strength of the current a *shunt* is employed, the resistance of which bears a known ratio to the resistance of the instrument. The greater part of the current flows through it, only a small portion actually traversing the coils of the galvanometer.

STRENGTH OF CURRENT—OHM'S LAW.

Ohm's law, first deduced by him from theoretical considerations, has by the researches of Daniell, Pouillet, De la Rive, Wheatstone, and others, become of great practical importance in determining the best arrangement of a battery to obtain the greatest effect in any given case. Ohm laid down the important laws that (1) the strength of the current is equal to the electro-motive force divided by the resistance; and (2) that the strength of a current is inversely proportional to the length of the conductor, and directly proportional to its section and conductivity.

In a voltaic battery made up of a number of elements, the strength of the current is equal to the sum of the electro-motive forces of all the elements, divided by the sum of the resistances. In an ordinary element or cell two resistances have to be considered: the internal resistance of the liquid conductor between the two plates, and the external resistance, or that offered by the conductor which connects the two plates outside the liquid. This conductor may be wholly of metal, or partly of metal and partly of liquids to be decomposed. If C is the strength of current, E the electro-motive force, R the resistance of the cell, and r the external resistance, Ohm's formula becomes $C=\frac{E}{R+r}$. But if n number of elements are connected up together, there will be n times the electro-motive force, and n times the internal resistance; therefore the formula becomes $C=\frac{nE}{nR+r}$. If the external resistance r is very small, being a short length of thick copper wire, it may be neglected in comparison with the internal resistance, and the formula becomes $C=\frac{nE}{nR}=\frac{E}{R}$. Consequently, in this case a battery consisting of a number of elements produces no greater effect than a single element.

When the external resistance r is very great, as when the current has to traverse a long telegraph circuit, or is required to produce the electric light, then an advantage is gained by employing a large number of elements, the formula being $C=\frac{nE}{nR+r}$. But now, as r is very great as compared with nR, the latter may be neglected, and the formula becomes $C=\frac{nE}{r}$, which means that the strength is proportional to the number of elements within certain limits.

When the plates of an element are made m times as large, the electro-motive force is not increased, as this depends on the nature of the metals and of the liquid; but the resistance is m times less, as the plate surface is m times larger; the formula then becomes $C=\frac{E}{\frac{R}{m}+r}=\frac{mE}{R+mr}$. Consequently, an increase in the size of the plate, which is the same as a decrease in the internal resistance, does not increase the current strength to an indefinite extent, as ultimately the resistance R disappears in comparison with the resistance r, so that the strength continually approximates to the value $C=\frac{E}{r}$. Ohm's law applied to the potential of a battery is as follows:—

If there is taken a battery of six elements, it may be connected up in any one of these four ways—

1. In a single series, the Z of one element being united to the C of the second, and so on.
2. In a system of three double elements, each element being formed by joining two Z's together, and the two C's of this double element to the two Z's of the next two, and the two C's of this second double element to the two Z's of the third pair, of which the two C's are united.
3. In a system of two triple elements, each of which consists of three of the original elements joined, so as to form one of three times the surface.
4. In a system equivalent to one large element, all the six Z's being joined together, and all the C's being united, so as to form a single pair of six times the surface.

With a series of twelve elements there are six different combinations, and so on for any increased number of cells.

If, in the case of the battery composed under the first arrangement, the internal resistance, R, of each element is represented by 3, and the external resistance, r, is represented by 12; then $C=\frac{6E}{6R+r}=\frac{6E}{6\times3+12}=\frac{6E}{30}$.

In the second arrangement the electro-motive force would be that of each element, and there would be also an internal resistance, R, for each element, which would, however, be only half, as the surface of the plate is doubled. In this case the strength of the current would be

$$C^1=\frac{3E}{\frac{3R}{2}+r}=\frac{3E}{\frac{9}{2}+12}=\frac{6E}{33};$$

consequently this arrangement of the cells decreases the strength of the battery.

If with the same elements the external resistance, r, is taken as only 2, then the values will be respectively

$$C=\frac{6\times E}{6\times3+2}=\frac{6E}{20},\text{ and }C^1=\frac{3E}{\frac{3R}{2}+2}=\frac{6E}{9+4}=\frac{6E}{13}.$$

The latter arrangement in this case therefore gives the highest potential. If the external resistance, r, is taken as

9, it will be seen that the potential in both cases is the same. From this it follows that by altering the size of the plates or their arrangement, an increase or diminution of potential is obtained according to the relation between R and r.

In any given combination *the maximum effect is obtained when the total internal resistance of the elements is equal to the resistance of the conductor connecting the two terminal plates outside the battery.* If the total number of cells for any given combination be N, and if n be the number of elements connected in series, then $\frac{N}{n}$ will be the number of elements arranged abreast or in parallel; and if e is the electro-motive force, r the resistance of one cell, and l the external resistance, then the potential of the current will be

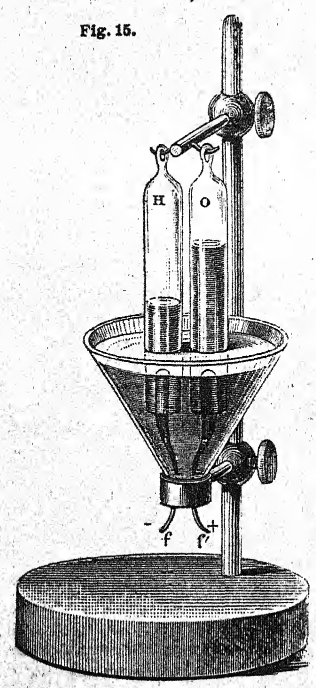
$$C = \frac{ne}{\frac{nr}{\frac{N}{n}} + l} = \frac{ne}{\frac{n^2 r}{N} + l} = \frac{e}{\frac{nr}{N} + \frac{l}{n}}.$$

The potential of C is therefore at a maximum when $\frac{nr}{N} + \frac{l}{n}$ is a minimum. But as $\frac{nr}{N} \times \frac{l}{n} = \frac{rl}{N}$ is a constant, the sum $\frac{nr}{N} + \frac{l}{n}$ is a minimum when $\frac{nr}{N} = \frac{l}{n}$, or when $\frac{n^2 r}{N} = l$, which is when the total internal resistance of the battery is equal to the external resistance. Consequently, from the above formula the best effect is obtained when $n = \sqrt{\frac{Nl}{r}}$.

CHEMICAL EFFECTS OF THE CURRENT.

Besides the chemical action which takes place inside the cells of the battery, and which always accompanies the production of a current, chemical actions are produced outside the battery when the current is passed through certain liquids. The action of the current in regard to liquids is various. Some liquids have no conducting power, such as petroleum, turpentine, and certain oils. Other liquids are capable of conducting a current without undergoing decomposition, such as mercury and other molten metals; while others again not only conduct the current, but at the same time undergo decomposition. To this class belong the dilute acids, solutions of the metallic salts, and various fused solid compounds. The decomposition of water into its constituent elements by the action of a voltaic current passed through it, was discovered by Carlisle and Nicholson in 1800. The constituent gases appeared in bubbles at the ends of the electrodes immersed in the liquid. The oxygen gas appeared at the electrode where the current entered the liquid, and the hydrogen bubbles on the electrode by which it left the liquid. This process of decomposing a liquid by means of an electric current was called by Faraday *electrolysis* or electric analysis, and those bodies which are capable of decomposition *electrolytes.* The wire by which the current enters is called the *anode*, and the one by which it leaves the *kathode.* Absolutely pure water is a non-conductor, but its resistance is greatly reduced by the addition of a few drops of sulphuric or hydrochloric acid. The apparatus employed for the decomposition of water is termed a *voltameter*; it consists of two glass tubes (fig. 15) closed at one end, which having been filled with water, are inverted into a glass vessel full of water. The tubes receive the gases evolved by decomposition of the water at the two platinum electrodes in connection with the battery inserted in each tube at the bottom end. The wires f, f', from the electrodes lead to the battery. In the process of decomposition of water there will be nearly two volumes of hydrogen gas (H) evolved at the kathode, for one of oxygen (O) evolved at the anode. This circumstance corresponds with the chemical composition of water, which consists of the two gases combined in the proportion of two volumes of hydrogen to one volume of oxygen. This proportion is not accurately maintained by electrolysis, as a small quantity of hydrogen is at first absorbed by the platinum electrode, and also about 1 per cent. of the oxygen is given off in the denser allotropic form of ozone, which is slightly soluble in water, and from its density occupies less space. The electrolysis of water is expressed as follows:—$H_2O = H_2 + O$. Water yields two volumes of hydrogen and one volume of oxygen.

Fig. 15.



In the electrolysis of water or other liquid, the atoms which are separated one from another, and invisibly carried by the current to the electrodes where they are deposited, are of two orders—one division travelling to the anode, the other to the kathode. Those which travel to the anode are termed *anions*, and those which travel to the kathode *kathions*, the atoms themselves being *ions.* The anions are considered to be electro-negative, because their motion is towards the + pole of the battery; the kathions are for the opposite reason supposed to be electro-positive. Hydrogen and metals which move apparently in the same direction as the current are kathions, and are deposited on the electrode where the current leaves the liquid. Oxygen, chlorine, &c., are anions, being deposited on the electrode by which the current enters the liquid.

The *quantitative laws of electrolysis* are—first, that the amount of chemical action is exactly equal at all points of a circuit; for, if two or more electrolytic cells are connected up in different points of a metallic circuit, the chemical action developed by the current will be the same in each cell, as the same amount of electric current flows past every point of the circuit in the same time. Thus, if all the cells contain acidulated water, the volume of hydrogen set free will be the same in each cell; or if they contain a solution of sulphate of copper, the same weight of copper will be deposited in each; and when some of the cells contain acidulated water, and others a solution of sulphate of copper, the volumes of hydrogen developed, and the weights of copper deposited, will be in chemically equivalent quantities. Again, the number of *ions* or atoms liberated at an electrode in a given time is proportional to the strength of the current flowing through the circuit. Consequently, a current of two ampères will accomplish twice the amount of chemical decomposition that a current of one ampère will in the same time. Again, the number of ions liberated at an electrode in a second, is equivalent to the strength of the current multiplied by the electro-chemical equivalent of the ion. One coulomb of electricity passing through water liberates ·000010352 gramme of hydrogen; consequently, a current of C ampères will liberate C × ·000010352 grammes of hydrogen per second. The value ·000010352 gramme is termed the electro-chemical equivalent of hydrogen. When the chemical equivalents of other elements are known, their electro-chemical equivalents are easily ascertained. Taking copper, the chemical equivalent of which is 31·5, by multiplying this by ·000010352, the electro-chemical equivalent of copper is ·0003261 gramme.

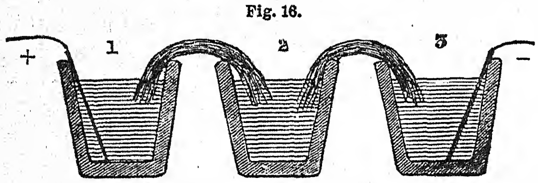
The weight of any given ion set free from an electrolytic solution, by a current of a given strength during a given time, is represented by the formula $w = zCt$, where C is the strength of the current in ampères, t the time in seconds, z the electro-chemical equivalent, and w the weight in grammes of the element liberated. By this formula, therefore, the weight in grammes of an element which has been deposited by electrolysis is determined by multiplying its electro-chemical equivalent by the strength of the current in ampères, and by the time in seconds during which the current flows.

ELECTRO-CHEMICAL EQUIVALENTS.

Name.	Atomic Weight.	Valency.	Chemical Equivalent.	Electro-Chemical Equivalent in Grammes per Coulomb.
Electro-positive—				
Hydrogen, . . .	1·0	1	1·0	·000010352
Potassium, . . .	39·1	1	39·1	·0004047
Sodium, ...	23·0	1	23·0	·0002381
Gold, ...	196·6	3	65·5	·0006780
Silver, ...	108·0	1	108·0	·0011180
Copper (Cupric), .	63·0	2	31·5	·0003261
Mercury (Mercuric),	200·0	2	100·0	·0010351
Tin (Stannic), . .	118·0	4	29·5	·0003054
Iron (Ferric), . .	56·0	4	14·0	·0001449
Iron (Ferrose), . .	56·0	2	28·0	·0002898
Nickel, ...	59·0	2	29·5	·0003054
Zinc, ...	65·0	2	32·5	·0003364
Lead, ...	207·0	2	103·5	·0010684
Electro-negative—				
Oxygen, ...	16·0	2	8·0	·0000828
Chlorine, ...	35·5	1	35·5	·0003675
Iodine, ...	127·0	1	127·0	·0013147
Bromine, ...	80·0	1	80·0	·0008282
Nitrogen, ...	14·0	3	4·3	·0000445

In chemical decompositions effected by the electric current there is not only a separation of the elements, but likewise a transfer of one to the + and the other to the − electrode. This was demonstrated by Davy, who placed a solution of sodium sulphate in two capsules connected by a thread of asbestos moistened with the same solution; on immersing the + electrode in one capsule and the − in the other decomposition took place, and after some time the soda was found in one and the sulphuric acid in the other capsule. In a second experiment solution of sodium sulphate, dilute syrup of violets, and pure water were respectively placed in three glasses, and connected together by the moistened asbestos threads, as in fig. 16. A current was then passed

Fig. 16.



from the glass containing the water to that containing the sulphate. In the course of time only soda remained in the glass, the acid having been transported to the glass containing the water, which was +. On reversing the direction of the current the soda was found in the water, the acid being left in the glass; but in both cases neither the passage of the acid, nor that of the base through the glass containing the syrup of violets, caused any change in its colour. The theory of electrolysis put forward in 1805 by Grotthüss explains this phenomenon. Assuming that in every binary compound, or body which acts as such, one of the elements is electro + and the other electro −, then, under the influence of the contrary electricities on the liquid in which they are immersed, a series of successive decompositions and recompositions from one pole to the other is set up, so that only the elements of the terminal molecules do not recombine, and remaining free appear at the electrodes. In the case of water, which is composed of one atom of oxygen and two atoms of hydrogen, the first being electro-negative and the second electro-positive, the oxygen of the molecule in contact with the + pole is attracted and given off at the + electrode, and the hydrogen is repelled and at once unites with the oxygen of the next molecule of water (as represented by the half-shaded circles in fig. 17), and the hydrogen of this with the oxygen of the next, and so on to the − electrode, where the last atoms of hydrogen become free and appear as bubbles of gas. This theory also applies to the metallic oxides, to the acids, and salts, and will explain the reason that the syrup of violets become neither red nor green. Clausius has applied this explanation to the modern theory of the constitution of liquids, which supposes that in the usual state of a liquid the molecules are always in movement among themselves, and their constituent atoms likewise in movement, and that these molecules and atoms are continu-

Fig 17.

HO HO HO HO HO HO HO HO HO HO

ally separating and recombining into similar groups, their movements taking place in every possible direction throughout the liquid. Under the influence of an electro-motive force it is assumed that these actions are controlled in direction, so that when an atom separates from a group in the course of the usual movements, it will tend to move toward either the anode or kathode, and if the current is sufficiently powerful to prevent recombination these atoms become permanently separated, and accumulate around the electrodes (fig. 17).

In using the voltameter to determine the intensity of a current, there is the objection that it does not indicate the strength at any given moment, as to obtain measurable volumes of gas the current must have some duration of action; and again, it gives no indication of any change which may take place in the current during this time, but only the mean intensity. It likewise offers great resistance, and can only be employed with strong currents. The indications of the voltameter are governed by the acidity of the water, the intensity of the current, and the distance and size of the electrodes. Measurements of the strength of a current by the deflections of a magnetic needle are therefore more accurate than by chemical means. Such indications, however, vary with the force of the earth's magnetism in different places, with the diameter of the galvanometer coil and the number of turns of wire, and the indications only hold good for the specific instrument used. The indications of the two instruments may, however, be compared with one another, if both are simultaneously placed in the circuit of a battery, and both the deflection of the needle and the volume of gas liberated in a given time are noted.

LOGIC.—CHAPTER XIII.

THE RELATIONS BETWEEN INDUCTION AND SYLLOGISM, ANTECEDENCE AND CONSEQUENCES—CAUSE AND EFFECT—THE RULES AND RESULTS OF INDUCTIVE RESEARCH.

Inductive research is man's method of endeavouring to transform the contingent truths of experience into the necessary truths of science. Facts which happen uniformly and invariably in the same manner and succession in precisely similar circumstances are those alone which can be included under the philosophic idea of *law*. Of course, experiences come to us as individual facts, but by the constancy of the impressions they make on us, and the lengthened and varied observation to which, by ourselves or others, they are subjected, these individual experiences become wrought together in our minds, by association, into a native and necessary oneness to which we give a name, and of which, in so doing, we constitute a class under and into which we gather all those experiences that impress us with a sense of their similarity, and from which we separate and set apart all that is found dissimilar or irrelevant. Thus, having (1) observed and experimented on a sufficient number of the well-ascertained facts of experience, (2) subjected to analysis all the phenomena they appear to exhibit, and separated all that are found to have no natural and invariable connection with each other, and (3) made, in memory or otherwise, a true and faithful record of all actual qualities and characteristics included in the idea these originate, form, and recall, we register and combine them all in some definite name. Then our nomenclature—aggregating, as it does, every class into a whole, because the individuals included in and under it possess some positive and special characteristics or manifest some distinct analogy inducing us to think of them as one whole—compels us to regard this class as one regarding which certain affirmations are true, and in that very act enforces the conception of

quite a different class in which resemblance to this either does not subsist or contrary qualities are manifest. Here affirmation and negation are possible, and here the syllogism enables us to test (*i.e.* make a mental experiment) by some appropriate middle term whether our (expressed or implied) affirmations or negations are correctly made and hold true in experience as well as in thought.

When a philosophic thinker is struck by the observation of any remarkable phenomenon, he feels impelled to ask—Can I get the opportunity of reobserving this fact? or can I reproduce the phenomenon by a faithful and accurate reproduction of the circumstances, in order that I may know on what its occurrence, and if possible its recurrence, depends? Thus he seeks an explanation of any phenomenon in an investigation of its immediately antecedent or nearest discoverable proximate cause. Here, again, we require to separate the special phenomenon to be examined into from anything extraneous with which it may be accidentally associated; and here, also, we find it needful to adopt an affirmative and a negative demarcation, and by a proper adoption of some method of proof—really a middle term—to determine between the intrinsic and the extraneous, and must adopt the syllogism as the regulative form for doing so. Not only in securing the properly authenticated consilience of facts in affirmative conclusions, but also in making sure of the accurate decomposition and trustworthy analysis of facts, we require to put our investigative inquiry through some intermediary form of proof in such a way as to enforce, if possible, an affirmative or negative conclusion. In all our researches regarding either the invariable connections of phenomena—that is, into (1) the immediate (or nearest proximate) occasioning, (2) the conditioning, (3) the prevenient, and (4) the concurrent antecedents of any (uncounteracted) cause or consequence—or the invariable disconnections of cause and effect—*i.e.* of the definite and clear absence of any (given, known, or suggested) phenomena from the entire series of the precedent (or it may be concomitant) phenomena, among which that under consideration became manifest as an effect—we must bring our views to the test of *yes* or *no* by a middle term, through which the relation or *ir*relation is proved. Should the state of the question, when properly tested, fail to yield a conclusion in A or E, and enforce our acceptance of one in I or O, then we require to re-examine our data in regard to (1) the concomitant increase or decrease of the intensity of an effect with the increase or diminution of certain antecedents, including the proportionality of consequence to cause in such cases as show the direct and unimpeded action of certain invariable antecedents, and (2) the cessation of the investigated effect on the withdrawal or non-operation of certain antecedents. The results of these reinvestigations will enable us to attain, in the first instance, conclusions in I or O, and show the advisability of resuming research, so as to narrow the inclusiveness of the *all* or *none* of our former generalizations, till we have found a definite classification, in regard to which, on re-testing, we can deduce conclusions in A and E. Just because the human mind desires to convert as many as possible of the contingent truths of experience into the necessary truths of science, it is intolerant of exceptions—for any exception within a universal would be a contradiction.

Science is impatient of exceptions, insists on eliminating them, indicating them distinctly if single, and, if several, arranging them in sub-classes regarding which specific affirmations and negations can be made. It insists on knowledge being precise and certain. But in the actual experience of man knowledge varies much in precision and certainty. We have, for instance, very precise and certain information regarding the size, motions, and phenomena of the heavenly bodies; but regarding meteorological phenomena, climatic change, &c., we have not, as yet, attained certain scientific knowledge, nor have we the grounds for making precise statements. When knowledge has attained its maximum of precision and certainty it forms science. Induction is the means by which experience is transformed into science. Induction reveals (1) the *coexistences* of things and qualities, and leads to classification; (2) the *similarities* of things, and leads to analogy; and (3) the *causes* of things, and leads to science. Classification examines, divides, subdivides, groups, and arranges the objects of experiences. Analogy, by bringing the grounds of similarity and dissimilarity strongly before the mind, induces the idea of a relation among the like, and conflict or irrelation between like and unlike. The analogy extends from likeness of quality (examples and instances) to likeness of relations (hypotheses) and likeness of successions (causative inferences). Experiences of similar quality are expected to be the results of similarities of antecedence, and to issue in similarities of consequence. Such invariable sequences of relation are called *laws*, and we designate that one (or more) of the invariable antecedents (or those) which essentially precedes the occurrence of any phenomenon or series of phenomena, the cause (or causes) of the sequence. The *antecedent* is all that must exist or coexist in a particular manner prior to the resulting of any effect; the cause is that antecedent or set of antecedents from which an effect follows, and without which it cannot, so far as we know, happen. A *law*, in the inductive sense, is a statement of the invariable relations between the causes and effects of the facts we see. A *reason* is a statement possessed of such convincing force as to satisfy the mind regarding the adequacy of a cause (in its *insilience* or single direct action, or in its *consilience* or co-operative activity) and the applicability of a law—as (1) regulative of the events of experience, or (2) sufficient as an explanation to the curiosity of the mind regarding any causative activity in nature.

In induction we pass, by inference, from the accurately known (*i.e.* the sufficiently explained) to the unknown, or rather the not-understood relations of phenomena only somewhat known. Experience gathers, but induction uses facts. The constructive genius of a thinker, following out some more or less definite idea, selects that quality in a fact which unites and groups them. Knowing (or accepting as a general principle) that the operations of nature, so far as experience extends, proceeds on a uniform plan, and that all well-grounded instances of expectancy, based upon that sameness of the order of things, have been justified in their results, he assumes (1) that similar causes—unless counteracted by some other equally powerful and immediate cause—will be followed by similar effects; (2) that any similarly co-operating sum of causes, similarly concurrent and immediate in activity, in a similar condition of facts will produce similar results; (3) that whatever modifications in the activity or application of immediate proximate single or concurrent causes may take place, a proportionate modification is to be expected in the effect; (4) that if the direct cause of any effect operate through any intermediate means, or manifest itself as the agent in the communication of energy to a series of causations, these means or series must be taken into account as intervenient; (5) that if any preventive cause is introduced between the operant cause and the generally resulting effect, that interfering cause must be reckoned for, as either in whole or in part affecting the result; (6) that though similar effects may result from apparently different causes, either distinct, in alternation, or in combination, we may reason regarding cause and effect, from cause to effect or from effect to cause, to ascertain what effects they produce in common, and what divergent effects, for the better determining of the specific causes of any one or more of those similar effects, and, if possible, separate in thought unique, simultaneous, and joint causation. Any facts so connected (originating proximate cause) as antecedent and (immediately resulting, though not ultimate) consequent are regarded as bearing towards each other the relation of *causation*.

Causation is a word of many implications. In looking at a statue, for instance, we may say, the proximate invariable antecedent cause is the sculptor. He is, in one sense, the *efficient* cause; but his tools, or those of his workmen, and all the mechanical appliances required to excavate, move, prepare, and work the marble, let us say, constitute *instrumental* causes. The sculptor's special skill in design and craft of chisel, the position to be occupied by the statue, the nature of the block on which he works, and the purpose to be kept in view in its production, constitute *conditioning*

causes. The constructive ideal or plan of the work, suggesting or prescribing and regulating the form or pattern to be followed, operates as the *formal* cause. The motive of the work, that which led to its being fashioned, is an *occasioning* cause, and the purpose to be accomplished by the production of the work (*i.e.* the aim of the promoters, if any, of the work) require us to recognize a *final* cause. But the motive and the purpose have a prevenient existence, and constitute an *exciting* cause. How many of these "things apt, thoughts fit"—circumstances of time, power, and place, and "place with wishing"—must "cohere and jump" before all is found convenient for the completion of the whole varied series of causation which the statue represents and embodies in order that it might become that marvel of art and thing of beauty which has sprung into being as the effect of these several causes working some direct, some consilient—and it might be some resilient as well—but all influencing the production, as it is, of the "confixed" marble. In asking for as well as in speaking of causes we require to keep in view the specific cause sought or spoken of; for a cause which would be explanatory in one point of view would obviously not be properly explanatory of cause in another aspect. Physical differs from moral causation, and philosophical from political, and hence the application of inductive logic in regard to the discovery of causes may vary, while the regulative efficacy of its laws may be binding upon each endeavour to find the true causes of real effects. If causes operated as singly, separately, and distinctly in actual fact as they can be conceived of in intellectual process, there would be little room for mistake, some need perhaps for sagacity, but little for a logic of induction.

It is to accomplish, as far as possible, the bringing into the view of the mind, in a direct and obvious manner, the specific relations of cause and effect that induction seeks to pair off the complicated phenomena of nature into correlated couples of antecedent and consequent cause and effect. As an aid in doing so, inductive logic supplies the following suggestions:—(1) The sole invariable antecedent of a phenomenon is (probably) its cause. This is called *the method of agreement.* Supposing six different circumstances seem to be antecedents of a given effect, and one by one each of these circumstances is left out of account, and that the effect persists, though these are withdrawn in every instance except one, on the elimination of which the particular effect vanishes; the antecedent thus shown to be efficiently connected with the appearance and disappearance of the phenomenal effect is probably the cause of it. (2) Any antecedent which—while all other circumstances remain exactly the same—is invariably present when any special phenomenon is manifest, and invariably absent when that phenomenon is absent, is [probably] the causative antecedent of the simultaneously appearing and disappearing phenomenon. This is designated *the method of difference.* So it is proved that friction is a cause of heat by experimenting with wood and ice. Those two methods signify, in short, (*a*) that whatever *can* be eliminated from among the antecedents *is not* causatively related to the effect, while (*b*) whatever *cannot* be eliminated *is* so related. We may, however, proceed to make assurance doubly sure, and may employ the joint method of agreement and difference in cases where we have an invariable conjunction between two successive phenomena, though showing the antecedent not singly but in combination with something else. Here we bring together (*a*) instances in which the circumstances agree in nothing but the presence of the phenomenon under investigation and this antecedent, and (*b*) instances which agree in nothing but the absence of the phenomenon and this antecedent. If, then, these are the only circumstances simultaneously present in the one and simultaneously absent in the other, we have probably in the antecedent the cause. This law is stated thus:—(3) If two (or more) instances in which the phenomenon occurs have only one circumstance in common, while two (or more) instances in which it does not occur have nothing in common except the absence of that circumstance, the circumstance in which alone the two sets of instances differ [invariably] is either (*a*) the effect, or (*b*) the cause, or (*c*) the necessary and indispensable part of the cause or effect forming the subject of inquiry. In cases of the consilience of causes, if we want to know how much is due to any one of each (or each separately), we require to employ *the method of residues*, viz. (4) "subduct from any phenomenon such part as is known by previous inductions to be the effect of certain antecedents, and the residue of the phenomenon is the effect of the remaining antecedents," few or many, among which we must next proceed, if necessary, to prosecute further investigations by the preceding canons, or by employing the method of concomitant variations, which is (5) "Whatever phenomenon varies in any manner, whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon, or [since they may be effects of some common cause] connected with it through some fact of causation." Thus, as the intensity of the cause increases or diminishes so does the effect, and as the strength of counter-causes increases or diminishes, so is the ratio of the reverse of the effect increased or lessened. Those antecedents which, as they vary and are modified, are followed by a correspondingly varying and modified effect, especially if the changes are measurable, quantitatively or qualitatively supply us with the means of estimating the composition of causes and the incidence of resilient causes. The great difficulty in inductive research arises from the co-operation of a plurality of causes and the occurrence of intermixture of effects, the interposition of nullifying influences between cause and effect, and the transformations which causes may undergo through an entire series in which the initiatory cause results in an effect which is itself, in turn, a cause and sometimes an excitant of causes. In all these cases, however, though dealing with that which is invariably before an effect arises, or which ensues immediately after a cause, we are really endeavouring to discover what that is in antecedents which brings about consequents. Besides interpretation we see foreseeing and reproducing power. Invariable contiguity and continuity of relations cannot be regarded as contingencies. Our experience is our rule: that we examine and analyze; out of that we construct syllogistic arrangements of thoughts; these we test by the acts and facts of which we have or can acquire knowledge. When, by thought, the facts are brought into ordered series and sequences, the laws of things are learned, the causes of phenomena are known. Inductive search has resulted in instructive science, and thus correlatively while science explains experience, experience confirms science. Induction secures the precise equivalence of idea and object, syllogism exhibits the exact correlation of ideas, and science formulates the certain correlation of things.

CHEMISTRY.—CHAPTER XVI.

ORGANIC CHEMISTRY—QUANTITATIVE AND QUALITATIVE ANALYSIS—ANALYSIS OF A SHILLING—COMPOUNDS CONTAINING HYDROGEN, NITROGEN, CHLORINE, SULPHUR—QUANTITATIVE ANALYSIS, IRON ORE, &c.—ANALYSIS OF NITRE, COMMON SALT, GLASS—SIMPLE VOLUMETRIC ANALYSIS—NORMAL SOLUTIONS: HYDROCHLORIC ACID.

ORGANIC chemistry is the chemistry of the carbon compounds. As many of these compounds are found formed in the bodies of plants and animals, this branch of chemistry has received the name organic chemistry, and is usually separated from inorganic chemistry, as the number of compounds which have to be investigated is so large, and their constitution frequently so complicated, that they naturally follow the more simple inorganic compounds. It has already been pointed out that the number of the carbon compounds is almost unlimited, and that they are almost all formed by the union of carbon in different proportions with one or more of three other elements, namely, hydrogen, oxygen, and nitrogen; and that the number of atoms of these elements contained in the molecule of many organic bodies is very large, for instance sugar contains 45 and stearine 173 atoms of their constituent elements. Thus the multiplicity of the carbon compounds arises from the power which this element possesses of uniting with itself to form complicated compounds. Carbon is a tetratomic element; its simplest compound is marsh gas (CH_4). In this compound the four combining bonds or poles of the carbon atom

are saturated, or satisfied, by union with the four atoms of hydrogen, and any one or more of the four atoms of hydrogen can be replaced by one or more atoms of any other monad element; thus, taking chlorine, the substitution products obtained from CH_4 are—CH_3Cl, CH_2Cl_2, $CHCl_3$, CCl_4.

The process which determines the relative amounts of the constituents of a body is termed quantitative analysis; and that which simply determines the nature of these constituents, and the mode by which they may be separated, qualitative analysis. This latter form of analysis always precedes the first, it being necessary to ascertain the elements present in a substance before their proportions can be estimated. The methods of quantitative analysis are divided into gravimetric and volumetric analysis. Under the first the weight of the known constituents of a substance, either in the elementary state, or in the form of combinations which may be exactly weighed, and of which the composition is accurately known, is sought to be determined. Thus, to determine by weight the composition of a shilling coin, qualitative analysis has shown that it is made up of silver and copper. The proportion of the two metals may be determined in the shilling, either by separating them out and weighing them in their metallic state, or by converting the silver into silver chloride, and the copper into cupric oxide, and weighing the two compounds. Then, as the composition of the silver chloride and cupric oxide are known, the amount of silver and copper respectively contained in them can be calculated, and the relative quantities of the metals present in the coin determined. Generally in practice it is found more convenient to estimate the constituents in a body, by the assistance of combinations of known composition, than to isolate the elements. A correct knowledge of the proportion in which the various elements are present in these combinations is therefore of the highest value, and the exact determination of the combining or atomic weights of the elements a matter of the first importance. Again, the amount of silver in the shilling might be determined by ascertaining the quantity of hydrochloric acid required to convert it completely into silver chloride. When hydrochloric acid is added to a solution of silver in nitric acid (silver nitrate) an insoluble silver chloride is obtained, and if a sufficiency of hydrochloric acid is added the whole of the silver is thrown out of solution; thus—

$$AgNO_3 + HCl = AgCl + HNO_3.$$

If the amount of hydrochloric acid (HCl) contained in any given volume of the solution employed to precipitate the silver is known, and the exact point at which the formation of silver chloride ceases is determined, the amount of silver can be calculated from the volume of acid required, as the equation gives 36·46 parts of hydrochloric acid as equivalent to 107·93 parts of silver. This is the fundamental principle of volumetric analysis, a form of quantitative analysis which estimates the amount of a substance from the determinate action of reagents in solutions of known strength, the amount of the reacting substance being calculated from the volume of liquid employed, which is easily seen by dropping it from a graduated vessel shaped as in fig. 1 or 2.

Organic substances containing hydrogen, when heated with cupric oxide, are converted into carbon dioxide and water. By absorbing the products of the combustion in suitable apparatus and weighing them, the amount of carbon and hydrogen in the substance analyzed may be ascertained from the knowledge that forty-four parts of carbon dioxide contain twelve parts of carbon, and that eighteen parts of water contain two parts of hydrogen. When the sum of the amounts of carbon and hydrogen is equal to the weight of the body taken, the substance contains only these elements; if the body contains oxygen in addition, the difference gives the amount of this constituent. When the organic substance contains nitrogen it is usual to estimate the carbon and hydrogen in one portion, and to determine the nitrogen in a second quantity. Nitrogenous organic bodies, when burnt with copper oxide, more especially if free oxygen be present, are liable to evolve nitroxygen compounds, which condense and vitiate the results of the carbon and hydrogen calculations. By passing the mixed products of combustion over heated metallic copper the nitrogen compounds are decomposed; the oxygen combines with the copper, and the nitrogen remains unabsorbed. In the combustion of organic substances containing nitrogen it is necessary therefore to introduce a cylinder of copper gauze into the apparatus, which is to be kept at a bright red heat during the operation. The carbon and hydrogen may then be determined accurately in the ordinary way. In the determination of nitrogen by volume, the substance is burned by a mixture of

Fig. 1.

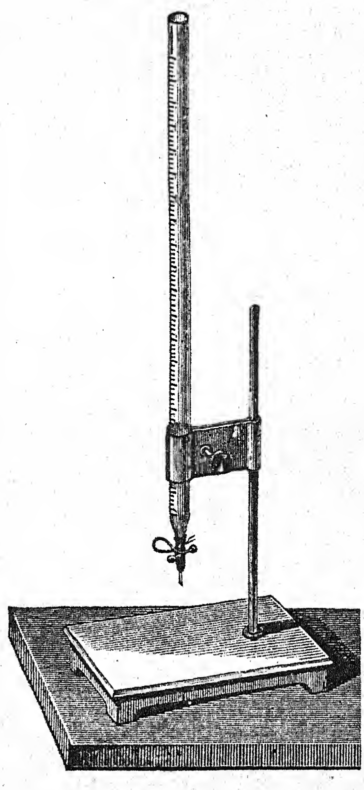
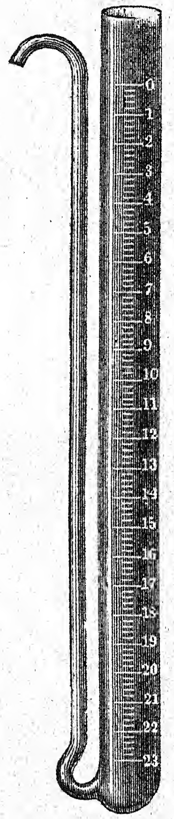


Fig. 2.



cupric and mercuric oxides in a tube, from which the air has previously been expelled by a current of carbon dioxide, and the products of combustion, together with the excess of free oxygen, are passed over strongly-heated metallic copper, which retains the latter gas; the remaining gases are collected in an apparatus standing over mercury and partly filled with strong solution of caustic potash, which absorbs the carbon dioxide; the residual nitrogen is transferred to a measuring tube placed over mercury, and its volume accurately determined. From the known weight of a litre of nitrogen the weight of the gas is easily calculated.

When an organic compound containing chlorine is burnt with cupric oxide, cuprous chloride is formed, which, being volatile, is carried forward in the stream of gas, and condenses in the tube of the apparatus, rendering the determination of the hydrogen inexact. If the gases within the tube contain free oxygen the cuprous chloride is more or less decomposed, cupric oxide being formed and chlorine eliminated. This is retained partly by the calcium chloride. By mixing the cupric oxide with a small quantity of lead oxide the chlorine may be entirely retained.

The determination of the carbon and hydrogen in compounds containing chlorine is best carried out by heating with lead chromate. This substance is easily made by mixing potassium chromate and lead nitrate or acetate solutions, and thoroughly washing the dense yellow precipitate, drying it, heating it to redness in a covered clay crucible, and coarsely powdering it.

The combustion of organic bodies containing sulphur is

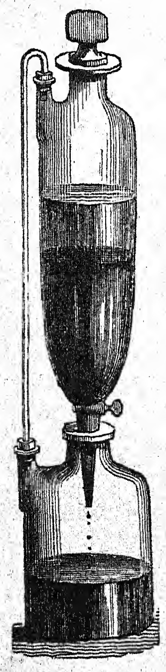
most accurately made with lead chromate. Care must, however, be taken to maintain the anterior portion of the combustion tube, to the extent of 15 or 20 centimetres, at a very low red heat. When this is done no sulphur dioxide passes into the absorption apparatus.

In quantitative analysis the careful selection of the specimen to be operated upon is of importance. Assuming that it is a cargo of ironstone or other substance that has to be inspected with a view of ascertaining its value, several lumps should be carefully selected from various parts of the mass, and the whole reduced to a coarse powder, from which, when thoroughly intermixed, a portion is taken for analysis.

In order to render the substance to be analyzed more susceptible to the action of solvents or fluxes, it is generally desirable to reduce it to a more or less finely-divided condition. Very hard substances are first broken into small pieces by wrapping them in paper and striking them with a hammer upon a smooth surface of iron.

The pieces are then reduced to coarse powder in a steel mortar. Some minerals which suffer no change on ignition, such as quartz containing gold, may be disintegrated by being repeatedly heated and thrown into cold water. By patient pounding and careful sifting through fine cambric or muslin the majority of substances may be sufficiently finely divided, all traces of grittiness disappear, and the impalpable dust finally cakes round the pestle. The mechanically held water, due to the method by which the body has been prepared, as in the crystallization of salts, or any moisture absorbed from the atmosphere, as in the case of certain minerals, must be driven off by drying before they can be analyzed quantitatively. If the substance contains water of crystallization repeated pressure between folds of filter paper may suffice to remove the moisture. Sometimes it is necessary to place the finely-pulverized substance in an artificially dried atmosphere over some hygroscopic material, as calcium chloride or strong sulphuric acid. Sometimes the desiccation may be hastened by placing it under diminished pressure in connection with an air-pump. Substances which experience no alteration by heat up to 100° C. may be quickly dried in a steam bath. If the body bears a higher temperature without change it may be placed in an air bath. When the substance is thus obtained in a fit state for analysis, a certain amount is weighed off.

Fig. 3.



In general, when the body is in the state of powder it is weighed out from tubes. The light glass tube containing the substance, and fitted with a good cork, is accurately weighed, the cork is then withdrawn and the proper quantity of the substance cautiously emptied out into a beaker or crucible; the cork being replaced, the tube and its contents are again weighed; the difference between the two weighings gives the amount of the substance taken for analysis. The further treatment of the substance depends upon the nature of the constituent or constituents to be estimated. Most frequently the body is brought into a state of solution either complete or partial, and the constituents separated either by evaporation or by precipitation, or by both processes. Thus, nitre in gunpowder may be determined by treating that substance with water, the salt being dissolved, and separating the solution from the undissolved portion, evaporating it to dryness, and weighing the residue. Common salt may be analyzed when in solution by precipitating the chlorine by the addition of silver nitrate and weighing the silver chloride produced; as the solution still contains the sodium as sodium nitrate, this after the removal of the excess of silver by proper means can be obtained by evaporation. Precipitation can only be employed when the precipitate is insoluble in the liquid in which it is formed, and when possessing a constant composition free from foreign substances and capable of being accurately weighed. The separation of the precipitate from the liquid in which it is formed is accomplished either by decantation or by filtration, or by a combination of these processes. The rapidity with which a liquid filters is proportional to the difference of pressure exerted on its upper and lower surfaces. In filtering volatile liquids these can be equalized by an apparatus similar to fig. 3. Simple gravimetric analysis may be illustrated by a few examples of well-known substances.

Sodium Chloride (NaCl, Common Salt).—Common salt rarely contains more than 98 per cent. of sodium chloride, its chief impurities being calcium sulphate and magnesium chloride. These substances cannot be removed by recrystallization, but by adding hydrochloric acid to a strong solution of the salt pure chloride of sodium is precipitated, and the calcium sulphate and magnesium chloride remain in suspension in the solution. About 70 grammes of salt are dissolved in a quarter of litre of hot water, the solution is filtered and saturated with hydrochloric acid gas. The salt begins to separate out almost immediately, and in an hour or more the process may be arrested. The liquid is then poured from the precipitated salt, which is washed once or twice with pure strong hydrochloric acid solution, drained, and gently heated in a porcelain basin. The moisture cannot be removed by filter paper, the strong acid causing contamination of the salt with the iron, &c., contained in the paper ash; the mass is therefore gently heated in a porcelain crucible until all the acid is expelled, powdered roughly while still warm, and a portion placed into a small dry tube furnished with a good cork. The residue of the salt is placed in a stoppered bottle for use in the subsequent operations. The chlorine is determined by a precipitation as silver chloride, by means of silver nitrate solution, thus:—

$$NaCl + AgNO_3 = AgCl + NaNO_3.$$

About 0·5 gramme of the salt is weighed out into a beaker of 80 cubic centimetres capacity, and dissolved in from 30 to 40 cubic centimetres of water; a few drops of pure nitric acid are added together with a solution of nitrate of silver. If sufficient nitrate of silver has been added the chloride separates out as a dense curdy precipitate. When all the chlorine is precipitated, the liquid is heated to nearly boiling point, and stirred occasionally with a glass rod. The precipitate is then allowed to settle in a warm place, where it is protected from dust and from light. The clear liquid is poured on to a filter, and washed twice by decantation with hot water; the precipitate is carefully rinsed on to the filter, washed five or six times with hot water, and dried in a steam bath. The dried chloride is then detached as completely as possible from the filter and placed in a weighed porcelain crucible, and heated very gradually until the chloride begins to fuse at the edges of the mass; it is then allowed to cool in the desiccator and weighed. When the chloride has been carefully protected from the light it will at most have a slight violet tinge, and the fused portion have the appearance of horn. The filter paper is folded and burned, the ash falling upon the chloride. The crucible and its contents are again weighed; the increased weight giving the amount of metallic silver originally adhering as silver chloride to the filter, together with the ash of the paper.

The known weight of the ash in the filter subtracted from the total increase gives the amount of reduced silver; this after being calculated to silver chloride is added to the main quantity. As an example:—

Sodium chloride taken,	0·4065 grammes
Crucible + AgCl,	8·9710 "
Crucible + AgCl + Ag + ash,	8·9813 "
Crucible,	7·9860 "

$$8·9813 - 8·9710 = 0·0103$$
$$\text{Less ash, } \quad ·0023$$
$$Ag = \ ·0080 = AgCl\ 0·0106$$
$$8·9710 - 7·9860 = 0·9850$$
$$\text{Total AgCl} = 0·9956$$

$$Cl = \frac{0·9956 \times 35·5 \times 100}{143·5 \times 0·4065} = 60·6 \text{ per cent.}$$

The fused silver chloride may readily be detached from the crucible by placing over it a small piece of zinc and adding a few drops of dilute sulphuric acid.

To determine the sodium the salt is converted into sodium sulphate by the action of strong sulphuric acid. After weighing a clean platinum crucible and lid, about a gramme of salt is introduced, and the increased weight gives the amount of the sodium chloride. Strong sulphuric acid is then added drop by drop, and after the reaction has subsided the crucible is gently heated from the top, the flame very gradually approaching the bottom. Care must be taken to prevent the loss of any portion of the sulphate by spurting. In a short time the whole of the hydrochloric acid will be expelled, and dense fumes of sulphuric acid evolved. As these diminish the heat is gradually raised, until the crucible attains a full red heat, at which it is maintained for fifteen or twenty minutes; when cool it is weighed. It is again heated to redness, and weighed a second time, this operation being repeated until a constant weight is obtained. The fused mass should be perfectly white.

Glass consists of a mixture of the alkaline silicates with certain insoluble silicates, generally of calcium, lead, iron, aluminium, magnesium, or manganese. The best window glass has approximately the composition $Na_2O,CaO,6SiO_2$. In flint glass the lime is replaced by oxide of lead. The pale green glass used for chemical apparatus mainly consists of silicates of lime and potash, mixed with smaller quantities of iron and alumina.

To analyze glass it is always reduced to the finest possible state of division and fused in a platinum crucible with four times its weight of a mixture of equal parts of sodium and potassium carbonates. When cool the crucible is placed in a porcelain basin, and the mass boiled out with water; hydrochloric acid is added in excess, and the whole is evaporated to complete dryness over the water bath. The dried mass is then moistened with strong hydrochloric acid, hot water is added, and the silica is filtered out, repeatedly washed with hot water, dried, and weighed. The solution contains the lead, iron, alumina, manganese, lime, and magnesia. The alkalies cannot be determined in this portion, being mixed with the salts required to decompose the glass. By passing sulphuretted hydrogen through the filtrate the lead is precipitated; filter and dry it, and convert it into sulphate by treatment with strong nitric acid. Add a few drops of bromine to the filtrate, and heat gently; then add some ammonia, and filter off the iron, alumina, and manganese. The lime and magnesia are then separated in the usual way.

To determine the alkalies about 1·5 gramme of the powdered glass is weighed out into a platinum crucible, and intimately mixed with 9 grammes of calcium carbonate and 1·5 gramme of ammonia chloride, and heated to a bright redness for an hour in a small furnace. The platinum crucible should be protected from the direct action of the fire, by being placed in a clay crucible with a little calcined magnesia at the bottom. When cold the contents of the crucible are treated with hot water, acidified with hydrochloric acid, evaporated to dryness to render the silica insoluble, and the silica then filtered off and weighed. A small quantity of lime water is added to the filtrate to precipitate the magnesia, and the liquid is boiled and filtered; to the filtrate, ammonia, ammonium carbonate, and a few drops of ammonium oxalate are added to throw down the lime. The liquid is boiled to render the precipitate dense and granular. It is filtered off, and the liquid is evaporated to a small bulk in a porcelain basin; pure nitric acid is then added in quantity, and the whole is evaporated to dryness to destroy the ammonium chloride. The saline residue is afterwards dissolved in a little water and filtered if not perfectly clear, and again evaporated to dryness with a small quantity of strong hydrochloric acid to expel the nitric acid. When the quantity of the mixed alkalies is considerable, this treatment, with hydrochloric acid, should be repeated to entirely dissipate the nitric acid. The alkaline chlorides are once more dissolved in a little water and evaporated to dryness in a weighed platinum dish, heated gently and weighed. The potassium chloride is then separated by platinum tetrachloride. Its amount subtracted from the sum of the chlorides gives the sodium chloride.

The principles of simple volumetric analysis of solids and liquids will be understood by a few familiar examples.

When a small piece of iron-wire is dissolved in dilute sulphuric acid, a solution of ferrous sulphate is obtained of a faint green tinge. By adding to this solution some substance which readily parts with its oxygen the colour changes to a yellow, the ferrous salt becoming oxidized and forming ferric oxide ($2FeO + O = Fe_2O_3$).

A few grammes of potassium permanganate ($KMnO_4$) dissolved in water produce a deep purple solution. Potassium permanganate, when in solution, readily parts with its oxygen; by adding a few drops of the liquid to the solution of ferrous sulphate containing free sulphuric acid the colour of the permanganate solution is instantly discharged. By adding successive quantities of the permanganate a point is reached when its colour is persistent. The nature of this reaction is as follows:—The potassium permanganate in the presence of free sulphuric acid is decomposed, permanganic acid is liberated, and sodium sulphate is formed. The permanganic acid in the presence of the ferrous sulphate and free sulphuric acid readily parts with its oxygen, and converts the ferrous salt into ferric sulphate, and itself becomes reduced to the state of manganese sulphate, a colourless solution. So long as any ferrous sulphate remains in solution, this decolourizing action will continue. So soon, however, as the whole is converted into ferric sulphate the red colour of the permanganic acid remains unchanged. The reaction is as follows:—

$$10FeSO_4 + 8SO_4H_2 + 2KMnO_4 = 5Fe_2(SO_4)_3 + K_2SO_4 + 2MnSO_4 + 8H_2O.$$

If therefore the strength of the permanganate solution is known, and the number of cubic centimetres that has been added to the solution containing a known weight of iron, as ferrous sulphate, before the solution is permanently coloured, the solution of permanganate may be used to determine the amount of iron in any given solution. For instance, if it were necessary to add 50 cubic centimetres of permanganate solution to 0·5 gramme of iron, dissolved in dilute sulphuric acid before the colour became persistent, then each cubic centimetre of the permanganate would be equivalent to 0·01 gramme of iron. Consequently, if the permanganate is added to a solution containing iron from an iron ore, and 25 cubic centimetres were needed before the colour became permanent, the amount of iron in the solution would be 0·25 gramme. Potassium bichromate may be employed as an oxidizing agent instead of potassium permanganate. The reaction will be then:—

$$6FeSO_4 + K_2Cr_2O_7 + 7SO_4H_2 = 3Fe_2(SO_4)_3 + Cr_2(SO_4)_3 + K_2SO_4 + 7H_2O.$$

By this equation therefore 294·4 parts by weight of potassium bichromate convert 336 parts of iron from the state of ferrous to that of ferric oxide. As potassium bichromate has a bright orange colour in solution, and the colour of its reaction on ferrous sulphate—namely, chromic sulphate, $Cr_2(SO_4)_3$, has a deep green colour which entirely masks the tint of the bichromate, recourse has to be had to some other method to ascertain when the whole of the ferrous oxide is converted into ferric oxide.

Ferrous salts give a deep blue precipitate or colouration when treated with a solution of ferricyanide of potassium; ferric salts produce no such colouration. When a few drops therefore of ferricyanide solution are sprinkled over a white surface, to which is applied a drop of the solution undergoing oxidation, the gradual diminution in the intensity of the blue colour will indicate the progress of the reaction, and its cessation will inform when the oxidation is complete.

SHORTHAND.—CHAPTER XI.

The list of consonant outlines which were given in the previous chapter will, with attention to the following rules, enable the learner to acquire a good style of rapidly written phonography.

The upward *h* may be joined to *p, t, ch,* thus *behave,* *Jehovah,* and also to *f, th, s,* and *sh;* but the words in which these combinations occur are not of very frequent occurrence.

The downward *h* may be joined to *ch, j,* or *h,* thus *heigh-ho,* to *s,* thus *Soho,* to *s* and *sh,* and to *p, k, m, l,* and the upward or downward *r,* thus *cohort,* *Elihu.* When *r* is the first consonant in a word, the upward *r* is written if a vowel follows, and the downward *r* is written if a vowel precedes; thus *ray,* *rock,* *run,* *air,* *arm,* *earl,* *error.*

There are a few words to which this rule does not apply, as it would produce an awkward outline, *e.g. arithmetic, article, earth, oracle, original, ornament,* &c. These, and such like words, the student's perception and taste should soon enable him to discriminate.

The same rule applies to final *r,* as *tare,* *tory,* *fear,* *fury,* *car,* *carry,* and also when a hook circle or loop is attached to *r,* as *earn,* *sir,* but it does not apply when the outline so formed would make more than one stroke below the line, nor when *r, r,* follow each other.

The same will hold good in the case of initial and final *l,* as *alike,* *long,* *along,* *fool,* *fellow,* *vale,* *valley.*

The *pl* and *pr* of double consonants should be kept for such words as contain no vowel, or an obscure one, but such words as *peel, pale,* should be written *peel,* *pale.*

The forms should be employed when a vowel follows them, as *fry,* *throw,* and the other series when a vowel or the prefix *con* or *com* precedes, as *offer,* *comfort.* In cases where another stroke occurs the student should select the most convenient outline, giving the preference, however, to if both are equally suitable.

Vowels may be joined to a consonant at the beginning of a word, thus *aw* before upward *l, waw, wŏ* before *k, r* up, *m, tr, chr,* and *shr,* and the diphthong *ī* before *t, sh, s, th, p, f, r* (down), thus *alteration,* *walk,* *item.*

Vowels may also be joined at the end of words, as *about,* *new,* and the vowel *w* (all) may be joined in *Almighty,* *already,* *almost,* &c.

The small *w* may be advantageously joined to *k, m,* and *l,* as in *wake,* *woke,* *wag,* *William,* *Wilson.* Before other consonants, generally, it is better to write the alphabetic *w.*

The student who desires to see the utility and to understand the advantage of these rules on the consonant outlines, will more readily grasp the bearing of them when he notices how they are used and has observed these rules illustrated in the shorthand portion of such periodicals as *The Phonetic Journal* and other publications devoted to the advocacy, diffusion, and practical employment of phonography.

We must now, however, endeavour to conclude the course of teaching contained in these articles by indicating as fully, yet as concisely as we can, the principles of contraction and the use of phraseography, both of which, together with a more extensive use of grammalogues, constitute the more marked elements of the reporting style of phonography.

When *p* occurs between *m* and *t, t* between *s* and another consonant, *k* between *ng* and *sh* or *ng,* and *t* or *g* between *ng* and *sh,* the *p, t, k,* or *g,* may be omitted in phonography.

The connective phrase *of the* is indicated by writing the words *near to each other,* as *love of the beautiful,* *plan of the work.*

In actual practice there is no difficulty found to arise from the similarity to the prefix *con* or *com.* The sense suggests the proper one.

The may be expressed by a short slanting stroke joined to the preceding word, and generally written downward, thus *in the,* *for the,* *of the,* *with the,* When more convenient it may be written up, thus *at the* *on the.* This, as it is technically called, tick *the* never begins a phrase.

He, when it follows another word may be written by a heavy upright tick, thus *if he,* *for he,* *that he.*

The following list of contractions should be carefully learned. In many cases they consist merely in joining the prefix or affix to the rest of the word; they will serve to indicate the principles on which contractions may be introduced without interfering with the ability to read them readily.

CONTRACTIONS.

Acknowledge-d
altogether *
anything *
architect-ure
Catholic
character *
Danger
destruction
difficulty
doctrine
domestic
Enlarge-d
especial-ly
essential-ly
establish-ed-ment
expect-ed
Govern-ed-ment
Immediate
immediately
impossible *
inconsistent
influence *
influenced *
influential *
information *
instruction
interest-ed
irregular
Kingdom *
knowledge
Magazine
manuscript
messenger
mistake *
more than *
(and so with *better than,* *rather than*)
Natural-ly
neglect-ed *
never
nevertheless
next
nothing
notwithstanding
Object
objection
Parliament-ary
peculiar-ity
perform-ed
Phonetic Journal
Phonetic Society
phonographer
phonographic
practice-cal-ly
probable-bly, probability
prospect
public-sh-ed
publication
Temperance Society
Rather, writer
reform-ed
reformation
reformer
regular
remark-ed-able,
remarkably
represent-ed
representation
representative
republic
respect-ed
Reverend
Satisfaction
satisfactory
something
Spelling reform
stranger
subject
subscription
surprise *
Thankful *
together
transcript
transfer
transgress
transgression[1]
Unanimous, unanimity
understand
understood
uniform-ity
Whatever
whenever
Yesterday

[1] *Transaction* should be written at length, because the contracted form might clash with *transgression.*

PHRASEOGRAPHY.

It is not unusual for swift writers in longhand to join several words together, and yet this is not found materially to interfere with the general legibility of their writing. The same principle is adaptable to phonography, and is termed phraseography [*i.e.* phrase-writing]. The judicious use of this mode of securing executive speed is one of the most important practical elements in rapid writing, but the student should at first be somewhat sparing in its use, and ought not to endeavour to join too many words together at once unless they are very familiar and almost self-suggesting. Phraseographs to be of real value must have easy and fluent joinings, and should be such as are not liable to be read off as or for a single word. The words should also have a close idiomatical relation to each other. Many simple phraseograms formed on the basis of the simple grammalogues will readily suggest themselves; *e.g.* *all that*, *shall be*, *as it.*

There is, or at least should always be, something characteristic about the phraseograms regularly used to prevent their clashing with or being mistaken for single words. The following examples show the manner in which phraseograms may be formed. Words marked * are written above the line:—

and have	is not	this is
and the *	it is	we are
as well as*	it is not	we have not
could not	it is said	we have seen
do not *	it should be	when he was
for this reason	it would be	which cannot
had not *	may be	who have
has not *	of course *	who would
he may	our own	you can
he would	should be	you cannot
I am *	should do	you may
I do	so that	you must
I have	that is *	you must not
I will *	they will	you will do

PUNCTUATION.

Stops are written in phonography as in longhand with the exception of the period, for which a small St. Andrew cross is used ×. The hyphen is written thus =; the dash.

Emphasis may be indicated by two or more lines, but if only one is used it should be made *wavy*, so that it may not be confounded with the horizontal-lined *k*.

Figures are written in the ordinary form, although the figures indicating *one* and *six* should be written thus—*1*, *6*—so as not to be mistaken for shorthand characters. They may also be used admirably in connection with shorthand characters, as *2* 2000, *3* 300, *4* 4,000,000.

The student should practise the principles of abbreviation according to the instructions contained in the preceding chapters, until he can write readily from sixty to seventy words per minute. Further principles of abbreviation are supplied in the *Reporter's Companion*, and the judicious study and use of these will soon enable the student to attain the desired goal of verbatim reporting. The great essentials are constant, careful, and systematic practice, and an unrelaxing endeavour to attain and keep up a clear and legible style rather than a strained and hasty striving after speed all at once. Here the old paradoxical maxim, *festina lente*, "hurry slowly," is of peculiar value. "Correctness first and speed afterwards" is the motto for successful study. Pursuing this course the persevering student will find effective speed attained as a result of his efforts more rapidly than he may even expect, for the confidence acquired by careful practice will enable him to go on unhesitatingly, when the less skilful would pause to consider—and be lost. He will assuredly be gratified afterwards when he knows that speed of graphic skill has not been acquired at the sacrifice of the ability to read readily what he has written rapidly.

This advice does not at all imply that "time is no object;" quite the reverse. Time is life, and time saved is life gained. This is, in fact, the great and crowning blessing which phonetic shorthand brings as a gift to mankind. The power of making an instantaneously rapid note for the help of memory must greatly lessen the strain on that mental faculty and impart greater confidence in conducting business than if everything were confided to the repository of recollection. "Thought is rapid," said a sage. Handwriting cannot match with it in speed, and only phonography can follow its current course and register rightly all that passes in quick succession through the mind. How often are intervening processes of reasoning, interesting illustrations, condensed and racy phrases lost because the pen cannot keep pace with the thinker's eager haste to follow the matter which engrosses his mind? Here the phonographer can all but photograph every successive step in the stages of thought. In the haste of business many things are apt to slip out of mind; shorthand provides the means of almost unconsciously jotting down what most requires attention, and may thus often be made a peacemaker in the settlement of points which might otherwise be made subjects of dispute. Not only to the merchant in the market or the counting-house, the lawyer in consulting-room or court, the student at desk or in class, the author in his study, and the manager in his bureau, but in the every-day doings of life a knowledge of phonetic shorthand is valuable and useful. As a professional pursuit it opens many forms of advantageous occupation, and even as a recreative exercise the study of it is not to be despised. The lessons we have prescribed, the advice given, and the references made are sufficient to enable any one who applies ordinary and regular industry, care, and patience to what has been set before him to acquire a fair acquaintance with and skill in a shorthand which will be easily carried, often useful, sometimes indispensable, and generally a pleasure, if not frequently a profit.

MUSIC.—CHAPTER XII.

HARMONY—RULES OF HARMONIC COMPOSITION—CAUTIONS—CHORDS AND INVERSIONS ON SUPERTONIC, SUBMEDIANT, MEDIANT, AND LEADING NOTE—ILLUSTRATIONS, EXERCISES, &c.

THE instructions that have been given and the exercises supplied in the course of these lessons ought to have enabled the diligent student to understand the relations between the Tonic Sol-fa system and the Old Musical Notation, the mode of translating the one into the other, and the forms which each will take when transferred into the symbols of the other. We shall now, therefore, place before our students the illustrations which it may be necessary to give in one of the notations only, but alternating these, and giving it as a general exercise in each succeeding instance, to write out each illustration in the equivalent form of the notation not in that case employed.

In the exercises in harmony which have already occupied our attention, only three chords have been employed—viz. (1) tonic, (2) dominant (to which occasionally the seventh has been added), and (3) subdominant. It has been found that in the major key or mode these are all *major* chords, but that when the prevailing key is minor the tonic and subdominant are *minor* chords (p. 940), the dominant alone remaining *major*. These same three chords, it has also been shown, can be used not only in root-position, but in first and second inversions. The use of the second inversion is in each case, however, subject to many restrictions.

(1) It cannot be approached by leap in the bass from the inversion of another chord; for instance, examples **1** and **2** are prohibited forms of musical expression.

Key G.

1.	:f	m	:—	2.	:r	d'	:—
	:t,	d	:—		:se	l,	:—
	:r	d	:—		:t,	d,	:—
	:r	s	:—		:t,	m	:—

(2) It must be followed either (*a*) by a full chord on the same bass note; as

Key C.		*Key F.*	
:l	l :s	:f	m :r
:f	f :m	:d	d :t_1
:d^1	d^1 :—	:l	s^1 :—
:f	d :—	:f_1	s_1 :—

Minor.			
:f	f :m	:r	d :t_1
:r	r :d	:l_1	l_1 :se
:l	l :—	:f	m :—
:r	l_1 :—	:r	m :—

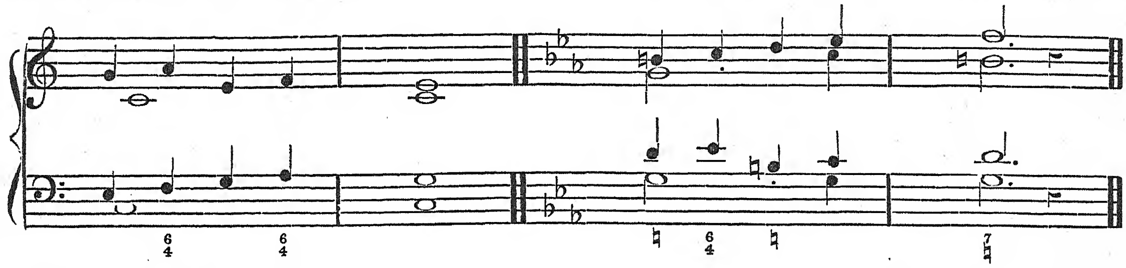
or (*b*) by a chord, or an inversion of a chord, which permits of the bass leaving the $\frac{6}{4}$ (C position), by step; as

Key F. Major.				*Key D. Minor.*			
m	f	m	f	d	r	d	r
d	r	d	d	l_1	t_1	l_1	l_1
s	l	s	f	m	f	m	r
s_1	f	s_1	l_1	m	r	m_1	f_1

While either of these three chords continues the bass is at liberty to leap up or down so as to produce a $\frac{6}{4}$ position, but, on finally leaving the chord, care must be taken that it is done in full observance of the foregoing rule (2).

(3) When followed by a chord on the same bass note the $\frac{6}{4}$ should be taken either on (*a*) the strong or (*b*) the medium accent.

An exception is made when the bass is being sustained in the form of what is called a pedal, when the $\frac{6}{4}$ may appear at any part of the bar; as



(4) The bass may freely leap to a second inversion from the root of another chord, and from either the root or an inversion of the same chord.

As already explained (p. 1040), the chord of the dominant seventh may be taken in all its inversions, but the second inversion is restricted in its progression, as it would be were there no seventh included. In cases where the bass of the second inversion rises one degree, the seventh (contrary to its usual habit) may rise also, thus

s	:—	m	:—
t_1	:d	se_1	:l_1
f	:s	r	:m
r	:m	t_1	:d

The third inversion of the dominant seventh may be approached by leap upward, but not by leap downward; as

With these three (or, including the dominant seventh, four) chords, any note of the scale may be harmonized; but the general effect is greatly improved by a judicious use of the certainly less important, though still very useful, chords built on the other tones of the scale. These are (1) the chord of the supertonic, (2) the chord of the subtonic or leading note, (3) the chord of the submediant, and (4) the chord of the mediant.

In the major key the supertonic chord is minor (p. 940), and may be used either (1) in root-position, or (2) in first inversion. It is employed chiefly as a substitute for the subdominant in approaching the tonic cadence.

ILLUSTRATIONS.

* *Key G.*			* *Root Position.*		
f :r	d :—		:f	m :r	d :—
r :t_1	d :—		:r	d :t_1	d :—
l :s.f	m :—		:l	s :f	m :—
r_1 :s_1	d :—		:r_1	s_1 :s_1	d_1 :—

First Inversion.

f :r	d :—		:f	m :r	d :—
r :t_1	d :—		:r	d :t_1	d :—
l :s.f	m :—		:l	s :f	m :—
f_1 :s_1	d_1 :—		:f_1	s_1 :s_1	d :—

Exercise 137.—Rewrite in the old notation, in G minor, the illustrations just given.

There can be no second inversion either of this or any other minor chord when used in the major key. In approaching the half close, this chord is so often made a means of harmonizing the notes Ray or Fah (minor Te and Ray) that it has come to be looked upon in such cases as a fixed progression; as

In the minor mode the chord of the supertonic cannot be taken in its root-position, because it is a chord having an imperfect fifth. Such a chord is, in its root-position, in every case disallowed. The first inversion of all such chords may, however, be freely employed; as

Exercise 138.—*Key B♭* Fill in Alto and Tenor. J. S.

d :—	d :r	t :—	d :—	d :d	r :t_1	d :—
d_1 :—	f_1 :r_1	s_1 :—	m_1 :—	f_1 :m_1	r_1 :s_1	d :—

Exercise 139.—Add three parts (S. A. T.) to given Bass.

Key G. J. S.

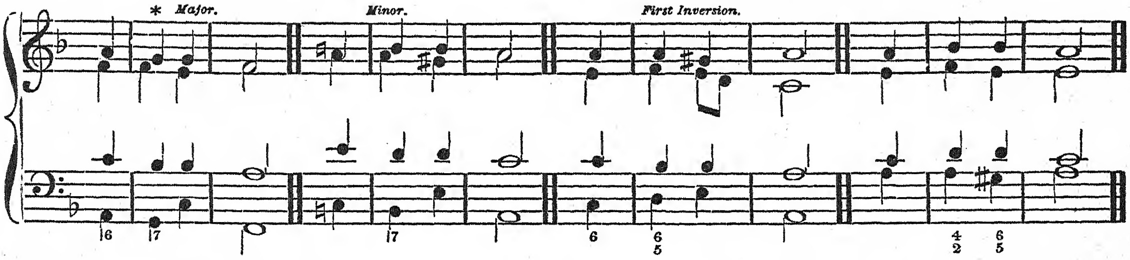
D :—	D_b :R_b	S :—	D :—	D_b :F	R :^{7}S	D :—

Exercise 140.—Harmonize the following.

Key B (G Minor). J. S.

d :—	l_1 :t_1	se_1 :—	l_1 :—	se_1 :l_1	t_1 :se_1	l_1 :—

Very frequently a seventh, which must be prepared (p. 1038), is added to the chord of the supertonic, in which case it can be employed in root-position, in first and third inversions, and in either the major or minor key.



Exercise 141.—Rewrite the minor illustrations above in the key of A major.

As a rule this discord is brought into prominence and has the best effect by being struck on the strong part of the measure. Occasionally, however, it is, as it were, carried back to the preceding weak pulse, when the dissonating Doh (or in minor Lah) is held through the chord which intervenes, and is then finally resolved on the dominant; as

Key F.

s :f	m :r	d :—
d :d	d :t_1	d :—
s :l	s :f	m :—
m_1:r_1	s :s_1	d :—
^{7}R		

Key C (A Minor).

l :t	d^1 :t	l :—
l :l	l :se	l :—
m^1:f^1	m^1:r^1	d :—
d :r	m :m	l_1 :—
^{7}T$_\flat$		

An essential chord of the seventh, as this is called, may be taken on any note of the scale where, as in this case, it can be properly prepared and resolved.

A cadence on the chord of the supertonic is seldom employed. When it is so used the key requires to be well established beforehand, otherwise the effect is weak and the key relationship uncertain. From the same cause the progression from supertonic to tonic is forbidden, unless both chords are in their first inversion; as

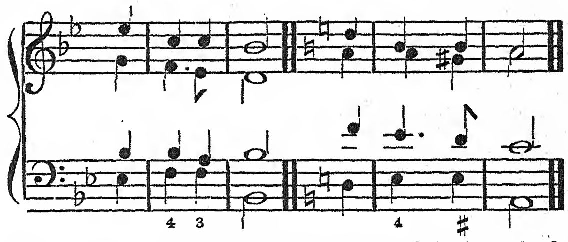
Exercise 142.—Fill in Alto and Tenor.

Key A. J. S.

s_1 :—	l_1 :t_1.d	r :—
d_1 :—	f_1 :f_1.m_1	r_1 :—

t_1 :—	d :r.m	f :r	d :—
s_1 :-.f_1	m_1 :f_1.m_1	r :s_1	d :—

It will be seen that the dissonance in the supertonic seventh lies between the notes Doh and Ray—the former intruding itself, as it were, into a chord where it is not required. The same dissonance, prepared in like manner, may be, and often is, introduced into the dominant chord; as



Here, however, the discord is what may be called self-resolved. This is called a suspension—in this case the suspended fourth (Sol-fa ^{4}S, minor ^{4}M). As shown above, it is used chiefly in approaching the tonic cadence.

Exercise 143.—Harmonize the following, using the suspended fourth as third last chord.

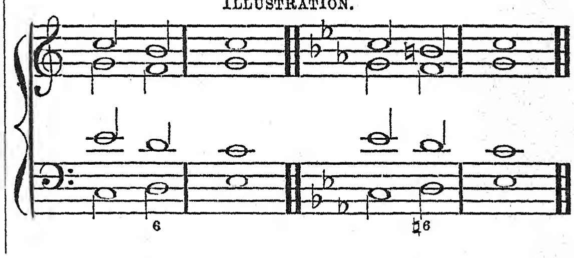
Key C (A Minor). J. S.

{|d^1 :—|t :l |se :—| m^1 :—|r^1 :d^1 |t :t |l :—||

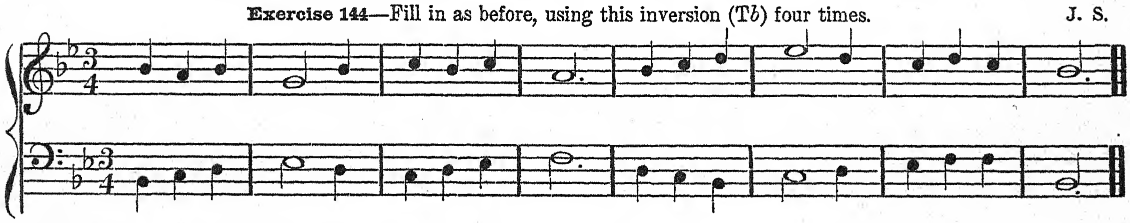
Like the seventh, the fourth may be suspended over any chord which admits of proper preparation and resolution. It may also be employed in its first and third inversions.

The chord on the leading note is, in both keys or modes, a chord having an imperfect fifth. Except in sequence, it cannot therefore be taken in its root-position, but in its first inversion, and as a substitute for the dominant it is often of great utility. In Sol-fa it is called T$_\flat$ minor Se$_\flat$.

ILLUSTRATION.

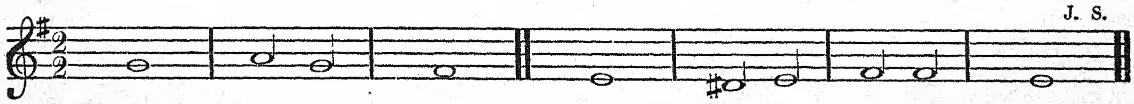


Exercise 144—Fill in as before, using this inversion (T*b*) four times. J. S.



Exercise 145.—Harmonize in four parts, using this inversion as the second chord, and the supertonic seventh as the third last chord.

J. S.



In approaching a tonic cadence this inversion is very often taken as the penultimate harmony, and in nearing the half-close it frequently occupies the position of third-last chord.

Composed as it is of the same notes, it is indeed by most writers regarded as simply the dominant seventh with the root omitted, and it may therefore be placed in all the positions hitherto assigned to that chord and its inversions. When employed in this manner Fah, seventh in the dominant, may be freely doubled, but the instructions regarding the leading note apply as formerly.

The chord on the leading note has frequently a seventh added to it, in which case the root position is preferred. Unlike that on the supertonic, this seventh is generally taken

unprepared with the dissonating seventh in an upper part, the effect being very pleasing and piquant; as

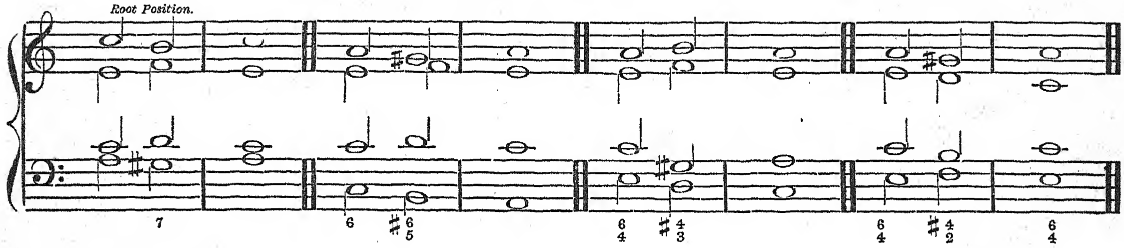
```
  F Major.                 A Minor.     (Doh is C.)
  s  :l   |s  :—  ||   :m' |d' :f'  |m' :—  ||
  m  :r   |m  :—  ||   :l  |l  :t   |d' :—  ||
  m  :f   |m  :—  ||   :d' |d' :r'  |d' :—  ||
  d  :t,  |d  :—  ||   :l  |l  :se  |l  :—  ||
     7T                        7Se
```

The progression of this discord—like that of the dominant seventh—is fixed; the seventh and fifth must fall, and the leading note must rise. The third (Ray, minor Te) is free, but if placed, as it frequently is, below the seventh, care must be taken that it does not proceed in fifths with that note.

Exercise 146.—Fill in Alto and Tenor, using the seventh on the leading note twice.

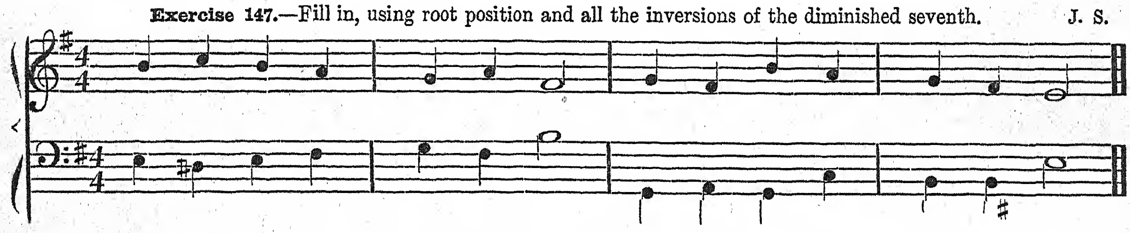
```
Key E♭.                                      J. S.
  d  :f   |m  :d   |r  :m   |f  :—
  d  :t,  |d  :m   |r  :d   |s, :—

  m  :l   |s  :d'  |d' :t   |d' :—  ||
  d  :t,  |d  :m   |r  :s   |d  :—  ||
```

Considered in relation to the major key, this discord may be freely used in the first inversion, but requires considerable discretion and experience for effective employment in the second. If taken in the third inversion the seventh must be prepared. In the minor mode it consists of three minor thirds, and is therefore called the chord of the diminished seventh. Here it can be taken in any position or inversion; as



In resolving the last inversion of the diminished seventh care should be taken that the part which has the third of the chord does not move in fourths with the bass.

Exercise 147.—Fill in, using root position and all the inversions of the diminished seventh. J. S.



The chord on the submediant (Lah, minor Fah) is a minor chord in the major key, but major when taken in the minor mode. It is employed (1) instead of the subdominant, to harmonize such melodic phrases as

```
  d  :r  |m  :—  ||   or   l,  :t,  |d  :—  ||
```

(2) instead of the tonic chord where a tender effect is wanted, and the note Me appears in an upper part; and (3) as a cadence chord preliminary to the final close—in which position has been called the surprise cadence.

ILLUSTRATIONS.

```
  Key G Major.          Minor.
  d  :r   |m  :—  ||l,  :t,   |d  :—  ||
  d  :t,  |d  :—  ||l,  :se,  |l, :—  ||
  m  :s   |s  :—  ||d   :m    |m  :—  ||
  l, :s,  |d  :—  ||f,  :m,   |l, :—  ||
  L                 F
```

Surprise Cadence.

```
  s  :f   |m  :—  ||m   :r    |d  :—  ||
  d  :t   |d  :—  ||d   :t,   |l, :—  ||
  m  :r'  |d  :—  ||l   :se   |l  :—  ||
  s, :s,  |l, :—  ||m,  :m,   |f, :—  ||
```

Exercise 148.—Fill in Alto and Tenor, using Lah (submediant) twice and ⁴Soh once.

```
Key G.                                              J. S.
  d :—  |t, :r   |d  :—  |r  :—  |m :d   |r  :f   |m :—  ||
  d :—  |s, :s,  |l, :—  |t, :—  |d :l,  |s, :s,  |d :—  ||
```

The first inversion of the chord on the leading note exceptionally is followed by the submediant chord. See close of third section in the following exercise.

Exercise 149.—Add three parts (S.C.T.) to given bass.

```
Key C.                                              J. S.
  D    :—    |7Rd :7T  |D  :—  ||S   :—   |Db  :7R
  7Sd  :Db   |S   :—   ||D  :—  |7Rb :Tb  |L   :—
  S    :—    |Db  :F   |R  :S  |D   :—  ||
```

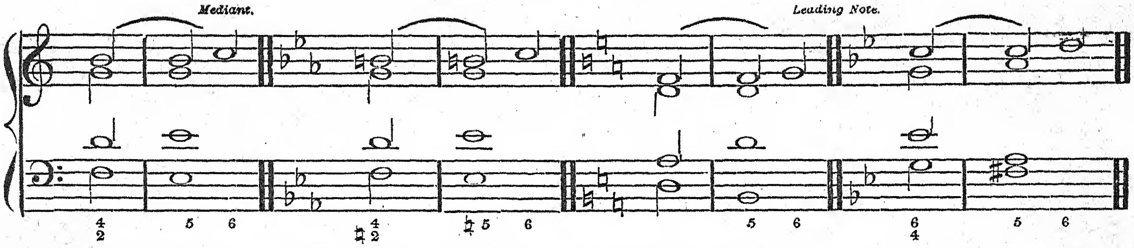
Occasionally the submediant is preceded by the first inversion of the dominant; and this is allowed—even in the minor mode—in which, however, not the major but the minor seventh of the scale must be employed.

ILLUSTRATIONS.

```
  Key F Major.        A Minor.
  m  :r   |d  :—  ||d   :t,   |l, :—  ||
  s, :s,  |l, :—  ||m,  :m,   |f, :—  ||
  d  :r   |m  :—  ||l,  :t,   |d  :—  ||
  d  :t,  |l, :—  ||l,  :s,   |f, :—  ||
```

This is the only instance (in this mode) of the minor seventh being used as a constituent of a common chord. The submediant chord may also be taken in the first inversion. It is, when so used, most effective in the minor key.

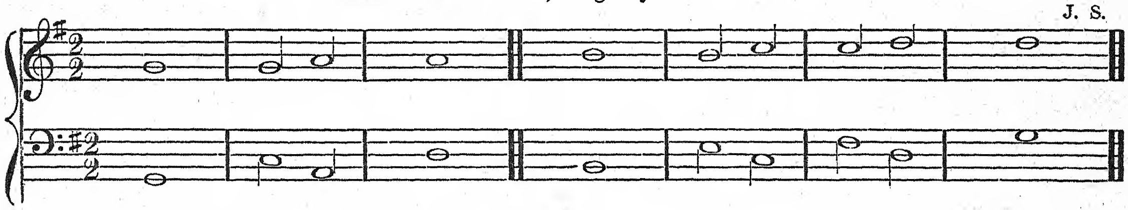
The last and least used of the minor chords is that on the mediant, which, owing to its harshness, can seldom be taken in root-position. If so taken it can only appear in the major key, and in a sequence when the ear is led to expect it. With its fifth (Te, minor Se), prepared and resolved upwards, it is classed among discords, and is known as the chord of the suspended fifth. As such it may be taken in both keys or modes. The imperfect chord on the leading note may be treated in a similar manner; *i.e.* it may be employed in a sequence without preparation, or as a suspended fifth; as



In the following exercise it will be observed that the bass goes up a fourth and down a third, from beginning to end. The other parts should move in a correspondingly regular order, and this sequential motion is held as sufficient apology for leaping an augmented interval, and for using direct chords on the mediant and the leading note.

Exercise 150.—Fill in, using only direct chords.

J. S.

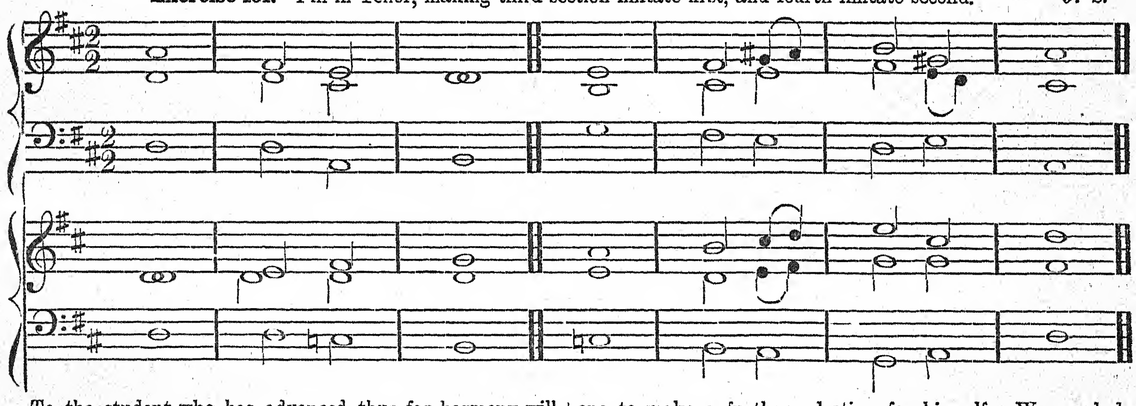


In the major key the mediant chord may be freely used in its first inversion. In the minor the fifth (Se) must always be prepared whether the chord is direct or inverted. The only way in which the mediant can, without preparation, be taken in the minor mode is by leaving out the fifth when it appears as a chord of two notes only—viz. Doh and Me—either or both of which may be doubled. In this case Me, the dominant, is most frequently taken as the bass note.

It will thus be seen that, in the major key, there are five common chords which may be freely employed—viz. tonic, dominant, subdominant, supertonic, and submediant, and that a first inversion may appear on every note of the scale. In the minor there are four common chords and six first inversions, the fifth of the scale being so employed, with the single interval of a sixth.

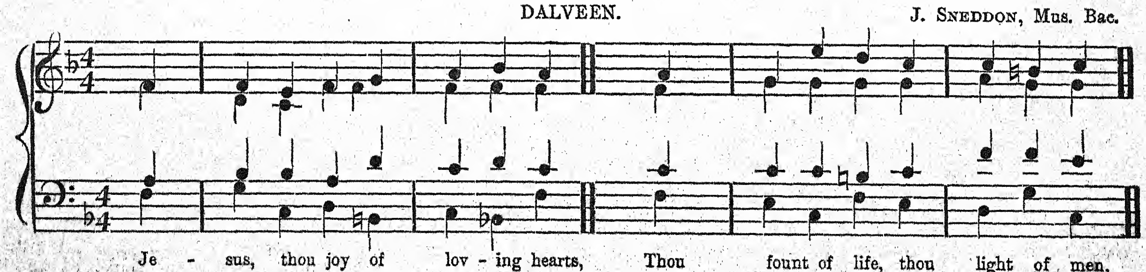
Considered in relation to harmony, transition (p. 656) and modulation (p. 755) are best taken gradually *i.e.* by a chord or chords common alike to the old and the new key. In this respect, what may be called the "shape" given to the bass is of great importance (see modulation, in second section of tune "Balfron," p. 855, and transitions, in second sections of tunes "Kinross" and "Govan," p. 856). The mediant is often used as the dividing place or point between two keys, *i.e.* a composer approaches this chord as mediant of one key, and quits it as submediant of another. Study illustrations of this at the openings of sections two and four in

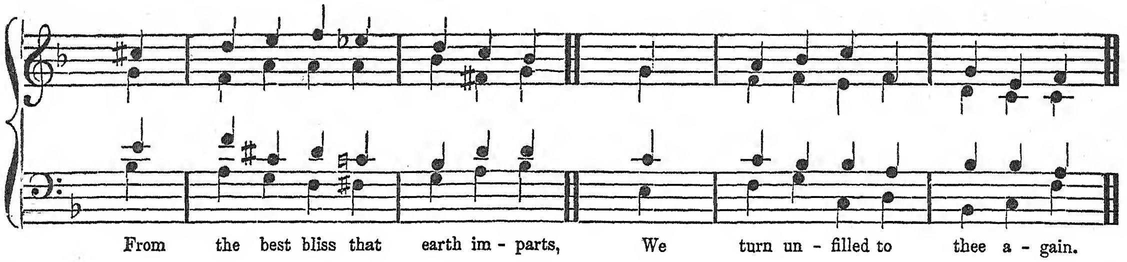
Exercise 151.—Fill in Tenor, making third section imitate first, and fourth imitate second. J. S.



To the student who has advanced thus far harmony will now be very interesting. We would recommend him to continue the study, using such books as Macfarren's "Rudiments of Harmony," together with his six lectures on the same subject, Curwen's "Commonplaces of Music," "How to observe Harmony," &c. A knowledge of these works will enable any one to make a further selection for himself. We conclude our harmonic illustrations with a tune in which most of those chords and modulations which have just been explained find a place. These the student should carefully note, and compare each instance with the rules and instructions given in the foregoing pages.

DALVEEN. J. Sneddon, Mus. Bac.





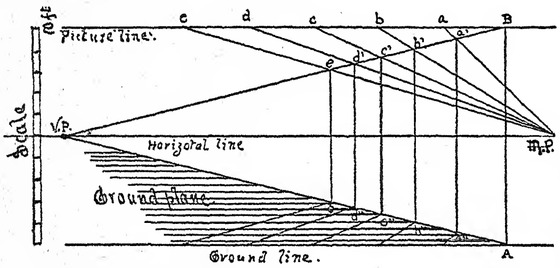
DRAWING.—CHAPTER XI.

PERSPECTIVE.—Part II.

The student will notice that in Plate XI. the window-sill and shutter are measured upon a picture line 3 feet above the ground. This is done because these objects do not actually rest upon the ground. Their lower edges lie in a plane parallel to the ground plane, but 3 feet above it. It would be possible to make all necessary measurements upon the ground, and to lift up the points obtained to the level of the objects by means of verticals; but it is more convenient and more scientific to make these measurements at the level of the objects to be represented. A line is therefore drawn on the picture plane (called "picture line") at the geometric height of the line to be measured, and this line is used in exactly the same way as the ground line.

This procedure is illustrated by the diagram here given (fig. 1), where the measurements on line B, V.P.—which line is in a horizontal plane 10 feet above the eye—are made upon a picture line at the same level, and are also made upon

Fig. 1.



the ground line and lifted up by means of verticals $a'a''$, $b'b''$, &c. In each case the measurements are made by means of the same measuring point (M.P.)

In the problem given opposite (fig. 3), the same method of measuring has been adopted for the projecting cap of the gate post.

In both of the problems presented in Plate XI. and fig. 3, several vanishing points are used. In fig. 3 a vanishing point is found for the half-open gate as well as for the two sides of the gate-post. The angle which the gate makes with the picture is shown on the plan (fig. 2); and a similar angle being made at the eye, a vanishing point may be found on the horizontal line.

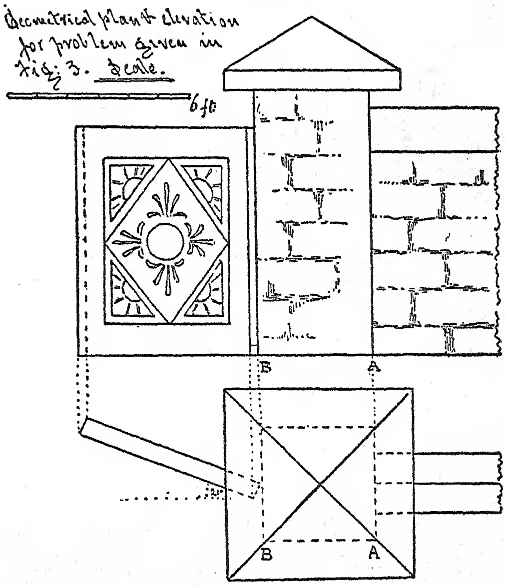
One shutter, shown in Plate XI., is parallel to the picture, and the other is set at right angles to it. The former will have no vanishing point, and the latter will vanish in the point of sight, as may readily be proved by making a right angle at the eye.

No new principle is involved in this development. Any number of vanishing points may be found and used; and—providing the position of the object be accurately stated in words or shown by a plan—it is perfectly easy to find those vanishing points by making at the eye the angle with the picture which is geometrically given either in the statement or the plan.

Each of these vanishing points must have its own measuring point. This is found by taking the distance from the vanishing point to the eye, and marking that distance along the horizontal line, as before described (p. 1144). All the points and lines have been carefully named and marked in the Plate and in fig. 3, and the student will do well now to study these problems carefully and work them out in detail—not merely copying the drawing here given, but endeavouring to work out the problems from the given statements, *taking the scale given in those statements*—namely, $\frac{1}{24}$, or half an inch to 1 foot.

Statement of Problem Figs. 2 and 3.—Given plan and elevation of a gate-post, wall, and half-open gate, to put these objects into perspective, when point A is 5 feet from the picture plane and 3 feet right of spectator; line A B to vanish to the left at an angle of 40 degrees with the picture plane; height of horizontal line, 5 feet; distance of eye, 10 feet; scale, $\frac{1}{24}$.

Fig. 2.



The methods of procedure described in the preceding pages are those which require to be practised and understood by candidates who enter for the elementary or "second-grade" examination by the Department of Science and Art.

The higher or "third-grade" examinations, in "advanced perspective," are divided into two stages. It is not possible, within our limited space, to go further than the first of these divisions, which is defined in the Government syllabus as follows:—

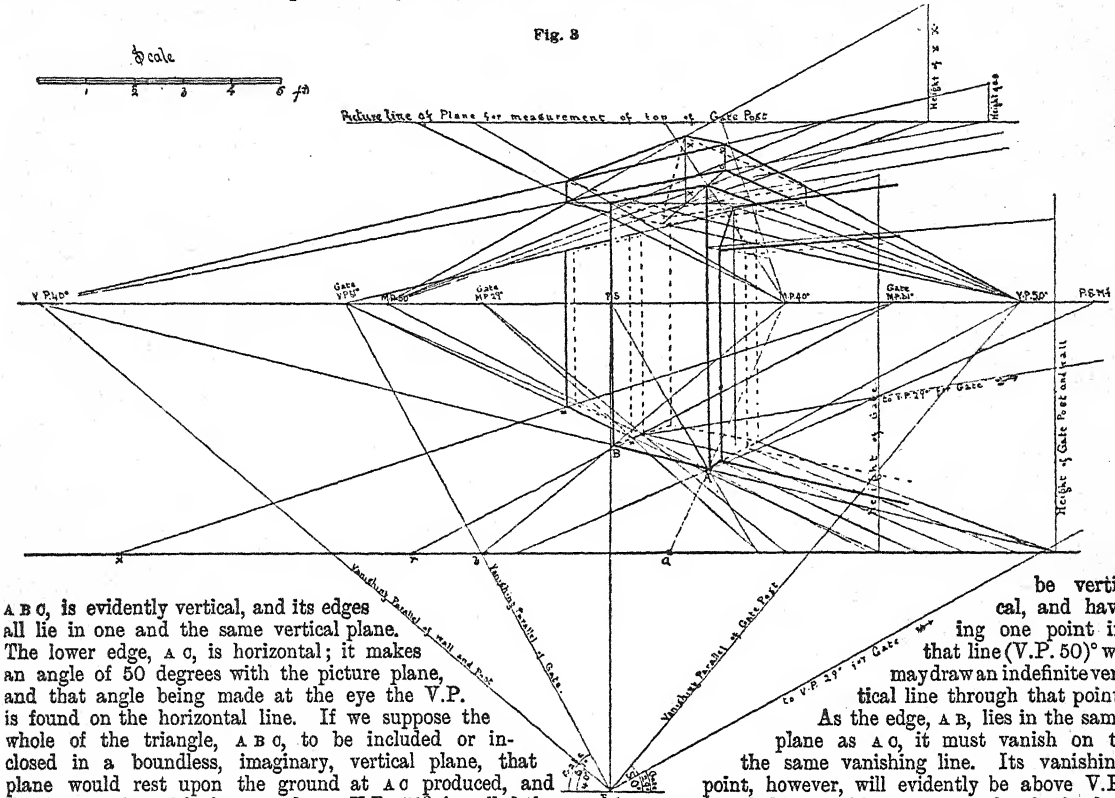
In addition to the knowledge required for the elementary examination, students will be required (1) "to place in perspective figures or solids, some of whose leading constructive lines are horizontal, and the others contained in vertical planes at right angles to the horizontal lines, *e.g.* a cube with one edge horizontal and one face making a given angle with the ground; (2) to find the reflections of such figures or solids in a horizontal reflecting surface; (3) to cast the shadows of such figures or solids upon horizontal and vertical surfaces by the light of the sun."

We propose to give such directions and examples as will enable the student to work out problems similar to those

indicated in the foregoing extracts from the Government syllabus.

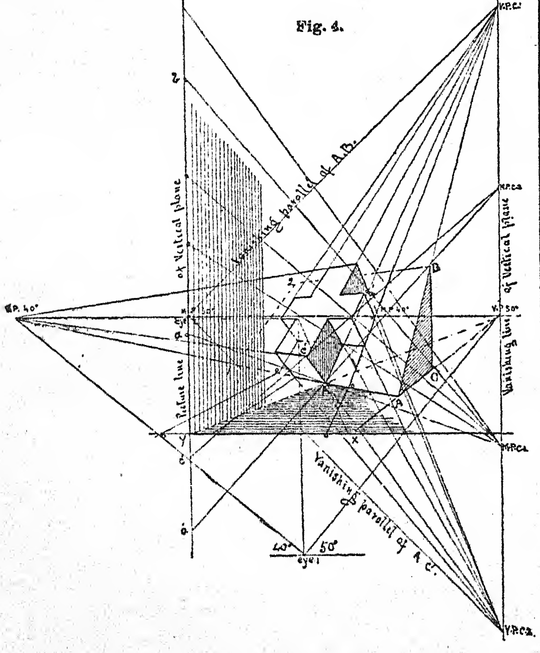
In fig. 4 we give a cross placed in the position of the cube described in syllabus, *i.e.* some of its edges are horizontal and others are contained in vertical planes at right angles to the horizontal edges. The cross is represented as lying upon an inclined plane, and its edges are parallel to those of the block on which it lies. As this block is a very simple figure, it will be well to take it as an illustration of the method of working. The near triangular end of the block,

Fig. 3



A B C, is evidently vertical, and its edges all lie in one and the same vertical plane. The lower edge, A C, is horizontal; it makes an angle of 50 degrees with the picture plane, and that angle being made at the eye the V.P. is found on the horizontal line. If we suppose the whole of the triangle, A B C, to be included or inclosed in a boundless, imaginary, vertical plane, that plane would rest upon the ground at A C produced, and this intersection with the ground, X—V.P. 50°, is called the trace of the plane.

Fig. 4.



Rule No. 1.—*To get the direction of any vertical plane, make at the eye the angle given in statement, and draw the vanishing parallel of the trace.*

The plane being a vertical one its vanishing line will also be vertical, and having one point in that line (V.P. 50)° we may draw an indefinite vertical line through that point.

As the edge, A B, lies in the same plane as A C, it must vanish on to the same vanishing line. Its vanishing point, however, will evidently be above V.P. 50°, and this vanishing point may be obtained as follows:—Place the steel point of the compasses in V.P. 50°, and transfer the eye to the horizontal line (eye 2). This is exactly the same procedure as that followed in obtaining a measuring point; in other words, take the *distance* from vanishing point of *trace* to *eye*, and measure it along the horizontal line. This operation is extremely simple, and is always performed in the same way. It is, however, much more difficult to understand why this is done, than to do what we have been directed to perform.

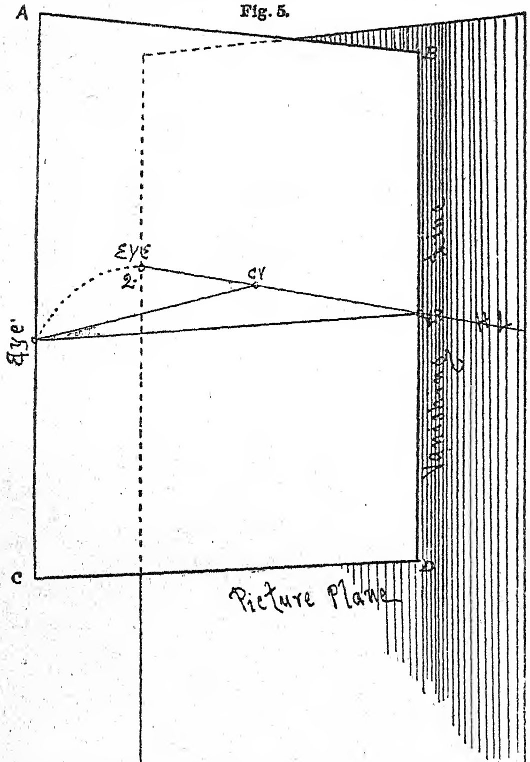
In Chapter X. (fig. 3, p. 1143) the eye is represented as being in front of the picture. At fig. 1, p. 1143, it is shown in its working position, that is, *revolved into the plane of the picture.* In this position we have hitherto used the eye, and set off at it the geometric angles, right or left, which objects made with the picture—that is to say, we have worked in a horizontal vanishing plane. Now, we are about to work in a vertical vanishing plane, and to measure angles up and down, *i.e.* the angles which objects make with the ground. To do this we must consider the eye to be in the vertical plane, A B C D (fig. 5), and this vertical plane must be "revolved into the plane of the picture," as shown at fig. 5. This will evidently bring the eye on to the horizontal line (eye 2, fig. 5), and in this position, or at this point, we may construct the angle which the line A B makes with the ground (angle 50°, eye 2, fig. 4); draw the vanishing parallel of A B, and so obtain its vanishing point (V.P. C. 1).

We will consider that A B is measured, as it may be, by drawing the vertical C B, and will now proceed to describe the construction of the cross.

The long edges of the cross are evidently parallel to A B, and will vanish to the same point. Having found A′ we may therefore draw the line A′ B′; it will then be necessary to measure this. The measuring point will be found on the vertical vanishing line, and may be obtained in the usual way, that is, by taking the distance from V.P. C. 1 to eye 2,

and measuring it down the vanishing line. Before using this measuring point it will be necessary to get a "picture line" on which to make the real measurements. The vertical plane which would contain the shaded side of the cross, and which is clearly shown in the figure, would be parallel to the plane containing the triangle A B C; it would therefore vanish on to the same vanishing line. But although two (or any number of) parallel planes may vanish on to the same vanishing line, each of these planes will have its own picture line. The obtaining of these picture lines is often a perplexing task in advanced perspective; but the difficulty

Fig. 5.



will be greatly reduced if the student will try to grasp the following rules:—

(1) *The picture line of a plane should always be parallel to its vanishing line.*

This is shown in all the problems we have hitherto given. When the horizontal line was the vanishing line, the picture lines were also horizontal; now that a vertical vanishing line is used (fig. 4) the picture line must be vertical.

(2) *The picture line should be drawn through the point at which the trace intersects the ground line.* For, it must be evident, at that point the plane touches the picture.

The picture line of the plane containing A B C should be drawn through point X, but it has not been drawn there because it was not needed. The "trace" of the plane containing A′ B′ C′, and the whole of the shaded side of the cross, is the line from V.P. 50° drawn through A′, and intersecting the picture at Y; through Y the vertical picture line is drawn, and on this line we may now make our measurements. Note.—This picture line in fig. 4 passes through eye 2, but this is merely an accidental coincidence; it has no necessary connection with that point.

Measurements in vertical planes are made in precisely the same way as measurements in horizontal ones; a line should therefore be drawn from M.P. C. 1 through point A′, on to the picture line (*a*), the real length *a b* measured up that line, and from *b* a line drawn back to M.P. C. 1. This gives the side A′ B′. The short side A′ C′ is evidently at right angles to A′ B′, and a right angle with the vanishing parallel of A′ B′ should be made at the eye (eye 2). The vanishing parallel of the short edge produces V.P. C. 2 on vertical line. The measuring point of this vanishing point is found and used exactly as described above, and as shown in fig. 4. The horizontal edges of the cross all vanish to V.P. 40°, and may be measured on A 1 in the ground plane—the measurements for the horizontal arm, *o o*, being continued up the inclined plane towards V.P. C. 1.

The student is recommended now to reverse this problem, making the vertical plane containing A B C vanish to the left; or by putting some other simple figure, such as a cube resting on an inclined plane, in a position similar to that of the cross, reduce to practice what has here been taught.

The problem in fig. 4 is almost identical with one given in the Government examination paper for 1887. The statement there given is as follows:—

"Draw, in perspective, the Greek cross shown in plan and elevation, with one edge resting on the ground and another edge against a vertical wall. The wall makes an angle of 40 degrees with the picture towards the left, and the nearest edge of the cross upon the ground is 2 feet to the right of spectator, and 8 feet within the picture."

We have represented the cross in our figure as lying upon an inclined plane (A B, 1 and 2), in order to simplify the explanation. The student might, with advantage, work out the problem as it is given in the Government examination paper, that is, with the upper edge of the cross resting against a vertical wall.

SHADOWS.

Shadow is defined as "the absence of light." If we suppose light to travel in straight lines or rays from a given source (*e.g.* the sun), and to fall upon an object, that object would be illuminated; but if any other object intervenes and intercepts any of these rays of light, some portion of the object No. 1 would be deprived of light, and a shadow of object No. 2 would be thrown or "projected" upon it. The exact appearance of this shadow can be shown by means of perspective, providing the position of the source of light (the sun) be accurately stated.

The sun may be (1) in front of the spectator, (2) parallel with the spectator or "in the plane of the picture," and (3) behind the spectator. In each case the position of the light must be accurately stated. The rays of light from the sun are then supposed to be inclosed in vertical planes, the vanishing line of these planes is found, and the angle which the rays make with the ground being set off at eye 2, the position of the sun, or the vanishing point of the sun's rays, is obtained.

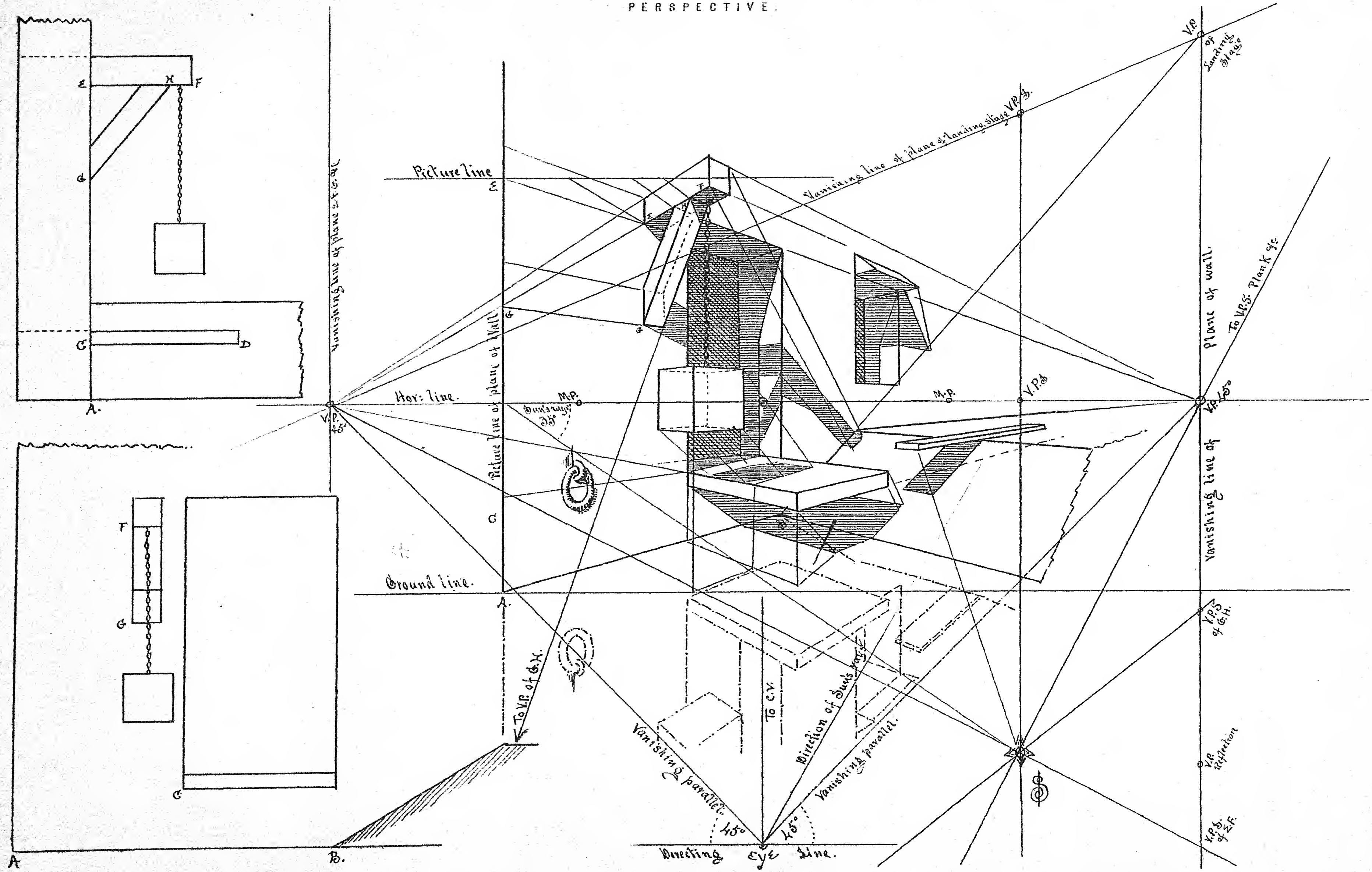
In our illustration (fig. 6) the sun is supposed to be behind the spectator on the right. In this position the rays will evidently come from a point above and behind the spectator, and will pass away or "vanish" to a point in front of and below the eye on the opposite (or left) side. The student can easily prove the accuracy of this statement by standing with his back to a light representing the position of the sun in our illustration given; and, while so standing, holding a rod over the right shoulder, pointing it towards the light. The portion of the rod in front of him will then point *downwards* towards the *left*. Therefore, when the sun is represented as being behind a spectator on the *right*, the vanishing point of its rays will be found *below* the horizon on the *left*. When the sun is in front of the spectator the rays vanish in the sun itself. In the position given in our illustration, however, the rays vanish in a point opposite to the sun.

This vanishing point of the sun's rays, in whatever position it may be given, is found in exactly the same way as the vanishing point of a real or "original" line, that is, the angle with the picture made by the vertical plane containing the rays is set off at eye 1, and the angle which the rays make with the ground is set off at eye 2. In fig. 6 the rays of the sun are shown in vertical planes making angles of 40 degrees towards the left, and these rays make angles with the ground of 25 degrees. The "sun," or V.P. of the sun's rays, is therefore at S on the vertical vanishing line. The point at which this vanishing line intersects H.L. will be the vanishing point of the shadow of the vertical lines on ground plane.

Rule 1.—*The vanishing point of a shadow is always on the vanishing line of the plane receiving shadow.* The shadow

DRAWING.

PERSPECTIVE.



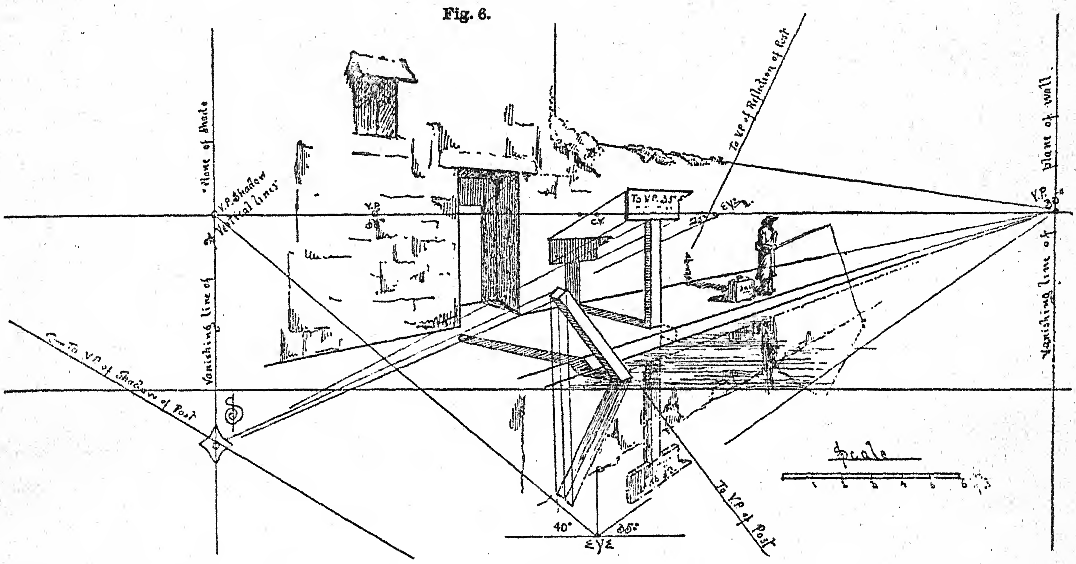
of the sign-post is therefore drawn towards V.P. until it reaches the wall, when the shadow becomes vertical. The height of this vertical shadow is determined by a line drawn from the top of the post to S. The shadow of the horizontal edges of the sign-board will go to V.P. 35°.

Rule 2.—*When a line casting shadow and a plane receiving shadow are parallel, line and shadow have the same vanishing point. Cor.*, when a line has no vanishing point (as vertical lines) line and shadow are parallel.

The shadow of the inclined post which stands in the water may be found by joining V.P. of post to V.P. of sun's rays. This line will intersect the horizon at a point indicated by the arrow on left of S, and that will be the V.P. of shadow on the water and ground. The vertical edge of the path is parallel to the post, and (by Rule 2) the shadow on it will vanish to the same V.P. as the post. The length of shadow is again, and in all cases, cut off by a line drawn to S. The other shadows shown in the illustration may be followed by a careful study of the lines in the figure and of the instructions given above.

(N.B.—The working lines used to obtain the forms in fig. 6 have been omitted.)

Fig. 6.



Reflections.—When simple forms are reflected in horizontal surfaces there is no great difficulty in representing the perspective appearance of these forms. The one simple rule for reflection is—*The angle of reflection is always equal to the angle of incidence.* The inclined post, for example, vanishes downwards at an angle of 50°; its reflection vanishes upwards at the same angle; if, therefore, the distance of V.P. below the horizontal line be measured above the H.L. the V.P. of reflection will be found. The same method may be adopted for all inclined lines, the length of the reflection being determined by a vertical line, as shown at the post in fig. 6. Vertical lines will have vertical reflections, but in some cases (as in that of the sign-post, fig. 6) the line does not reach the reflecting surface; it must be produced to meet that surface, as shown in the illustration. The length of reflection will be exactly the same below the reflecting surface as the length of line above.

The statement of the problem given in Plate XII. is as follows:—

(1) Two elevations are given of a wall of indefinite length and height, with a doorway and projecting landing stage. By the side of the doorway is a crane, and from it is suspended a cube. At B is an inclined landing stage of indefinite extent. The point A touches the ground line 8 feet left, and the line A B vanishes to the right at an angle of 45 degrees with the picture plane.

(2) Show the shadows of these objects when the sun is behind spectator at an elevation of 35 degrees, and its rays lie in vertical planes vanishing towards the right at an angle of 60 degrees with the picture plane.

(3) Show the reflections of these objects, the ground plane representing a sheet of calm water. Height of horizontal line, 6 feet. Distance of spectator, 14 feet.

Several lines used in obtaining these forms have been omitted in the Plate in order that the method of working the shadows and reflection may be left more evident. Note that the near corner of the cube touches the picture plane. A window and plank have been added to make the problem more attractive. The working of these items is simple and easily understood; and the student should not only observantly reproduce them, but endeavour to appreciate and understand them in all their relations, practical and intellectual.

HISTORY OF GREAT BRITAIN AND IRELAND.

CHAPTER XII.

ELIZABETH OF ENGLAND AND MARY OF SCOTLAND.

Elizabeth, in her twenty-sixth year, in the very prime of her stately beauty, was proclaimed by the Council—who, under the direction of Sir William Cecil (afterwards Lord Burleigh), had taken effective measures for a quiet accession—immediately after the death of Mary. On Sunday, 20th November, 1558, she met her Council, chose Cecil secretary of state, and Sir Nicolas Bacon lord keeper. Parliament acknowledged her legitimacy, admitted her prerogative, vested the exercise of the royal supremacy in the Court of High Commission, and she was crowned at Westminster, by the Bishop of Carlisle, 15th July, 1559. Protestantism was restored. The bishops, with two exceptions, took the requisite oaths, and Matthew Parker was consecrated primate. Almost immediately, Council and Parliament petitioned her to marry. But her position was too full of danger and difficulty to allow of such a definite step. Marriage, whether she chose a Protestant or a Catholic, required the sacrifice of the strength of her state. Religious rivalry was active at home; abroad, the Catholics espoused the cause of Mary of Scotland; but Scotland itself was ultra-zealous for Protestantism. Her harsh training in the school of experience had made Elizabeth cautious, and with cunning dilatoriness she temporized. For many years Elizabeth's policy was influenced by the changing events of religious controversy and political complications, as the thermometer by temperature; at the same time a large part of British, in fact European history was a skilful duel of duplicity between Mary Stuart and Elizabeth, both exquisitely well matched in the polished finesse of personal and political fence. The victory ultimately achieved by the latter was the result of personal

prudence and patience, dearly won by isolation and severe suppression of the finer feminine felicities of life. No gladiatorial show could compare in intensity of interest with the terrible contest to which fate had forced the issue of the Stuarts and the Tudors, while these Amazonian princesses, representatively, fought the fierce fight of foes for Catholicism and Protestantism respectively, and no drama of doom ever darkened upon the stage of time on merely human lives with such distressful scenes and incidents, such turbulence of passion and cross-purposes of plot, as that in which Mary of Scotland and Elizabeth of England played the leading parts.

England was at war with France, and Scotland was hostile. Any alliance with Spain was hateful to the people, yet Philip II. proffered Elizabeth marriage. She had to hold her own against the intrigues of religious parties, the encroachments of foreign powers, and the Pope's denunciations. She resigned Calais, made peace with France, and Philip, smarting with vexation, married the daughter of Henry II. At a tournament held during the nuptials, the sovereign of France was accidentally slain. On their accession, Francis I. and Mary of Scotland assumed, besides the sovereign title in France, those of King and Queen of England, Scotland, and Ireland. Scotland was afraid of being reduced to a province of France, and Elizabeth encouraged the Lords of the Congregation to resist. These were defeated by the French troops of Mary of Guise. Elizabeth sent an English army to their aid. The queen-regent died June, 1560. The French, under force of famine, sought peace, promised to acknowledge Elizabeth's right to the English throne, and departed. The Scots established Presbyterianism. Mary refused to ratify Cecil's treaty of Edinburgh; but Francis died 5th December, 1560, and as Mary Stuart was a childless widow, Catharine de Medicis seized the sceptre for her second son, Charles IX., and Mary, believing that she would more effectually advance her claims when urged from her indisputable throne, left Calais—after having been refused a safe-conduct through England by Elizabeth—and reached Leith, 19th August, 1561.

Mary was received with enthusiasm, and in two neighbouring states two queens held rule—each the centre not only of a court's intrigues or a country's disputes, but of the perplexities of Europe. How would they marry? was the question of supreme interest in that age. Policy brought them offers in plenty. The young Earl of Arran, who stood next in succession after Mary to the Scottish crown, and had been solicited as a consort for Elizabeth by Henry VIII., now made suit to her for that position. She thanked the Scots for "offering her the choicest person they had," but declined his wooing. Henry Fitz-Alan, earl of Arundel, premier earl of England, was a candidate for her hand; but she was not prepared to be the third wife of a subject aged forty-eight, whose son had, in her nonage, been proposed to her. Philip II. suggested that his cousin, Archduke Charles, second son of the Emperor Ferdinand, might be accepted. She expressed a desire to see him in England, but demanded conformity to Protestantism as an essential to marriage. Prince Eric of Sweden sued, but his proxy-pleader and brother John, duke of Finland, suspected of plying his own cause, was recalled. The prince proposed to come himself, but, having no hope held out to him, married the winsome, faithful, and virtuous "Kate the Nut-girl," a subject of his own. Meanwhile, the King of Denmark sent his nephew Adolphus, duke of Holstein, but he, though invested with the Order of the Garter, was allowed to return home. The handsome Protestant prince, Hans Casimir, eldest son of the Elector Palatine, being twenty-seven, while Elizabeth was thirty, in 1563, rejecting one of the beautiful Lorraines, became an aspirant for Elizabeth's hand and England's throne. Coyly or coquettishly, she was not taken by his portrait, and he consoled himself by wedding the eldest daughter of Duke Augustus of Saxe. Catharine de Medicis, who governed in her son's name, caused a proposal to be twice made to Elizabeth, to accept Charles IX. as consort. She replied, he was too great as a sovereign, and too small as a man; but suggested that her neighbour, Mary Stuart, might suit him better. Well might the Earl of Leicester, whom (it is probable) Elizabeth passionately loved, but was at once too cautious and too proud to marry—after long and varying flirtation—fret himself that "she had so many and great suitors that I know not what to do or what to think." She knew, however, that Rome, Spain, France, and Scotland, watched incessantly for one false step of hers in this matter, and her wary, perhaps selfish, self-command enabled her to avoid an act which would have imperilled her person and her throne.

Mary was the spoiled favourite of splendid possibilities. She was a widow of exquisite charms, and as the fair array of her suitors passed before her, not in imagination, but in real presence, she cast on them the magic of eyes brightened by wit and intelligence, and smiles gay with the gladness of one to whom the sweetness of love was life. A good many of Elizabeth's politic wooers on being rejected, transferred the offer of their slightly-stirred hearts to the queen of the northern realm, and perhaps Mary felt a natural joy in countenancing the addresses of those who had first greeted and graced the elder queen with their love-whisperings. The Kings of Sweden, Denmark, and France were severally suitors. The Archduke Charles, the Dukes of Ferrara, Nemours, and Anjou respectively, and the Earl of Arran, eldest son of the Duke of Chatelherault, head of the princely house of Hamilton, also advanced their claims. Don Carlos, the heir of the mightiest monarchy in Christendom, was placed by Philip among her dutiful admirers; and Elizabeth herself not only proposed Robert Dudley for her acceptance, but to make him more worthy in position of her regard created him Earl of Leicester and Baron of Denbigh. The queen-mother of France, and her kinsmen of the house of Guise, spoke with contempt of such a derogatory alliance; and Mary, probably knowing, from court gossip, the kindly relations which existed between Leicester and Elizabeth, thought that "Elizabeth had better marry him herself."

Suddenly Mary, tired of "the delay, caprice, and mystery" which Elizabeth kept up about marriage, resolved on choosing for herself. Her choice fell on Henry, Lord Darnley, son of the Earl of Lennox, who had been an exile in England, but had been permitted by Elizabeth to proceed to Scotland. There the queen saw him. He was of royal descent, his grandmother having been Henry VIII.'s sister. As first prince of the blood he had borne the sword of state before the Queen of England on Leicester's installation as an earl. His title to the throne of England was second only to Mary's own. An unchallengeable right to England's crown would be the inheritance of any child of such a union as theirs would be. So thought Mary; but Elizabeth and her council declared such a marriage "prejudicial to both queens and dangerous to the weal of both countries," and the Protestants looked with great displeasure on the match. Moray thought her "overhasty;" but the majority of the Scots barons admitted the expediency of the proposed marriage, and advised that it should be proceeded with. Elizabeth ordered Lady Lennox into custody, recalled Lennox and Darnley, "on their allegiance as her subjects," to England, and declared her entire disapproval of the marriage. Moray and the Reformers engaged in a plot to seize Darnley and consign him to Castle Campbell, at Dollar, and to imprison Mary for life in Lochleven Castle, Kinross. Mary's rapid progress from Perth to Callendar House, near Falkirk, enabled her to evade the conspirators; and she called on her subjects to meet her in arms, in the capital, to aid her against her enemies. On Sunday, 29th July, 1565, Chisholm, bishop of Dunblane, having brought from Rome a dispensation for the marriage, the nuptial ceremony was performed in the royal chapel of Holyrood at 6 a.m.; a banquet and festival followed in the evening.

Mary had now committed herself, and Elizabeth was, so far, mistress of the situation. But the younger queen was a woman of ready resource, splendid courage, and subtle mind. Instead of dallying or delay, she set upon the Scotch lords three days after her marriage. She chased them from Stirling to Glasgow, from Glasgow to Argyle, met Elizabeth's representative at Edinburgh defiantly, insisted on abstention from abetting rebellion, then, sweeping through Fife with an army, chastised several barons and prepared to press on to the border, to resist either rebel or invading force. As she neared Dumfries Lord Maxwell submitted, and Moray,

escaping into England, sought help at the English court; but there he was discountenanced. Mary called a Parliament for February, 1566, and expressed her resolve to proclaim forfeiture against Moray and his friends. Distrusting her nobles, and yet requiring an agent to conduct her secret correspondence with France, Spain, and Rome, a Milanese minstrel who had been brought to Scotland by Moret, an ambassador from Savoy, was, on the dismissal of her foreign secretary Paulet, employed by Mary as her amanuensis in regard to correspondence of political importance. David Rizzio, probably under the influence of Rome, exerted himself to the utmost to acquire power over the queen's counsels and mind. Mary was induced by him to join a coalition at this time formed by the Catholic states for the extirpation of Protestantism. Regarding him as an emissary and an enemy, the Reformers resolved to get rid of him. Thus alone did they think their ruin could be avoided. But this was an age when men of all classes studied duplicity as a fine art. They twitted the young king and his father with their failing influence and Rizzio's growing power. They hinted at the close personal intercourse established between him and the queen, and poured the poison of jealousy into Darnley's mind. He mistook her absorption in state schemes for devotion to Rizzio's company. Burning with the hot fever of revenge, he listened to traducing tongues, and joined in what they called a "judiciary" plot. On Saturday night, 9th March, 1566, while Mary was at supper in a small apartment adjoining her bedchamber, with her attendants, of whom Rizzio was one, Darnley, making use of a stair which led from his own bedchamber, entered the room and threw his arm round the queen's waist. Then Ruthven, clad in mail, ghastly from sickness, entered, followed by Douglas, Car, and other conspirators, who seized Rizzio, and, notwithstanding his entreaties for help from Mary, dragged him to the head of the stair, and there despatched him with fifty-six wounds, Darnley leaving his dagger sticking in the secretary's corpse. "Ah! Darnley, Darnley," cried the queen, "I shall never rest till your heart is as sad as mine is now."

James Hepburn, earl of Bothwell, a rash, daring, profligate man, who, during Mary's danger, had returned from France and given his aid to the queen against her rebel lords, now made himself active in her cause. Darnley had assumed sovereignty. Mary was kept prisoner in Holyrood; but artfully beguiling her husband, and cunningly evading her keepers, Mary escaped to Dunbar. There Bothwell, Huntly, Athole, and others rallied round her and denounced the conspirators as traitors. The queen, with an army, returned to Edinburgh five days afterwards, and the conspirators fled. After a short excursion into Stirlingshire, Mary took up her residence in Edinburgh Castle. During these two months of privacy, she reviewed the situation sadly, and found that in all the world she had not one trustworthy friend. On the morning of Wednesday, 19th June, 1566, James I. was born, and thanksgiving was made for so signal a mercy in the High Church of St. Giles. A fortnight before the murder of Rizzio, Bothwell had married at Holyrood Lady Jane Gordon, the Earl of Huntly's sister, and during the interesting event just noted, he, as Lieutenant of the Borders, was guarding the southern shires. Here, while preparing for Mary's progress towards those parts, he was wounded, and Mary, when she was there, visited him at Hermitage Castle, and next day became exceedingly ill. In the belief that she was dying, she made every preparation for the future of Darnley, James, the kingdom, and her servants. She recovered, and shortly afterwards returned to Edinburgh, where, while at Craigmillar Castle, at the suggestion of Bothwell, it was proposed to procure a divorce from Darnley. Mary distinctly refused to favour such a measure. Darnley had at this time a strong dislike to Mary's ministers, and had an inclination to seize the young prince, have him crowned, and hold rule as his father. A bond was entered into to remove Darnley, and it became the interest of the conspirators to implicate the queen in appearance with the scheme. Darnley lay ill at Glasgow, Mary had him removed by easy stages to Edinburgh, and as small-pox was infectious, had him brought to the lonely house of Kirk-a-Field, not far from Holyrood grounds. On Sunday, 9th February, 1567, Mary, rising from the marriage-feast of her French servant Sebastian, to Margaret Carwood, her waiting-maid, went, as she had regularly done, to visit Darnley, promising to return to the masque that had been prepared. Darnley was recovering, she kissed him, and giving him a ring left about 11 p.m. By 2 a.m. Kirk-a-Field was blown up, and the wearer of the crown-matrimonial perished in the ruins. Bothwell was instantly suspected of the crime. Lennox accused him. Mary ordered a trial. On 12th April he appeared in the city with an armed force and was acquitted. He had adroitly enmeshed the queen in suspicions, and on 24th, while Mary was proceeding from Stirling—where she had been seeing the prince—to Linlithgow, Bothwell seized her person and carried her off to Dunbar Castle. Here, where she was wholly in his power, Bothwell detained her till 3rd May. He then led Mary thence, under close guard, to Edinburgh Castle. Mutual suits of divorce, between Bothwell and his wife, were raised and disposed of by 7th May. Not until the banns had been twice published did Bothwell permit Mary to quit the castle. Led by him to the Court of Session she publicly pardoned the conspirators and Bothwell as her abductor. Having created him Duke of Orkney, on 15th May, Mary married Bothwell. Her nobles were instantly in arms. In a month she led an army against them; but on Carberry Hill (15th June) she renounced Bothwell and surrendered to the Lords of the Congregation. Bothwell paid ruefully for his criminal ambition. He was outlawed, imprisoned in an island in Norway, and ten years afterwards died mad. Mary had even a sorrier fate. She was taken to Edinburgh, where she was received with reviling by the rabble. Thence she was hurried to the island-castle of Lochleven, where, on 24th July, she was compelled to abdicate in favour of her son, who, five days afterwards, was crowned King of Scots at Stirling. On 2nd May, 1568, Mary escaped from Lochleven. An army of 6000 men gathered round her standard. The Regent Moray encountered her, 13th May, at Langside, near Glasgow. The queen's troops fled, and she, galloping 60 miles southward, reached Dundrennan Abbey. Here she remained two days, and after much hesitation, on Sunday, 16th May, resolving to throw herself on the sympathy of Elizabeth, Mary set sail in a small fishing boat, and landing at Workington, was led to the Castle of Carlisle—entering England not as a rival queen, but as a defeated and distressful fugitive. Thus for the present the great personal rivalry must rest. Mary was abased, Elizabeth exalted.

The chief difficulty which made itself felt in the realms of both queens was really an ecclesiastical one. Little as Elizabeth was able to interfere effectively in the affairs of Europe at her accession, she had managed to maintain her own power and prestige, and to protect the interests of England from foreign attack. Commerce languished, the common people were distressed, and ecclesiastical differences threatened to involve the land in civil war. She adroitly played off one enemy against another, until she was inoculated with the gambler's fascinated delight in the calculation and balancing of the chances, and the mere game gave her gaiety. She does not appear to have been a woman of deep religious convictions. Her Protestantism was largely political, and Puritanism found little favour in her eyes. The Catholics, though not openly disloyal, were always liable to be swayed by continental influences, and she wished to have an undivided front to show to them in the National Church. England's position and Elizabeth's power alike demanded that a definite basis of unity should be adopted in ecclesiastical matters. The basis of the Established Church could neither be so broadened as to permit of Catholic ritual, nor narrowed to the dogmatic doctrinalism of any of the dissenting sects. Unity of church and state in England could alone conduce to a policy which would restrain a civil war. Opposition to the papacy was essential to national independence, and hence the nuncio of Pius IV.—though prepared to approve of the faith and practice of the Church of England—was not allowed to put his foot on English soil. Politics made an Act of Conformity a necessity. So long as Elizabeth could encourage the discontented in Scotland and France, or under the Spanish sway, and yet control—if not suppress—the discon-

tented at home, her throne was tenable. The wary counter-plotting she employed procured peace during the first ten years of her reign; but Mary's advent at Carlisle complicated the whole plot-interest of the age, and a twenty years' conflict scarcely sufficed to establish her realm in peace and prosperity. Philip surrounded her throne with Spanish intriguers and fanned conspiracies. France fomented broil and battle for the furtherance of Catholicism in Scotland, and Jesuitism provided the most thoroughbred agents of diplomacy Europe ever saw. Philip was enthusiastically Catholic, and he subdued Spain to its power. On Cardinal Gravella he imposed the task of bringing the Netherlands into union with Holy Church. He failed, as Charles V. had done. Against the Inquisition the compromise of 1566 was signed, and Alva undertook to enforce submission. The "Blood Council" decreed death on Counts Egmont and Horn, who were beheaded 5th June, 1568, and on William of Orange, who opposed Alva, at first ineffectually, in the field. Protestantism thus menaced made common cause. The Huguenots rose in France. The Germans sent men, Elizabeth money, Orange and Count Louis of Nassau—though he had been defeated by the Spanish troops at Jemmingen (22nd July, 1568)—gave their aid. Condé was defeated and slain at Jarnac, another disaster occurred at Moncontour; but Coligny, in the district of Rochelle, held out, raised an army and threatened Paris. Alva's doings in the Netherlands created great alarm in England. Just then, however, the abdication of Mary Queen of Scots prevented a Catholic rising in England, and her subsequent downfall made anything of that sort for the time impossible. By the peace of St. Germain, France was quieted, August, 1570; but Pius V. proposing to weaken England effectually, issued a bull of excommunication against Elizabeth, which in May, 1570, was fixed by Felton on the door of the Bishop of London's house.

The coming of Mary to England had brought about this open and avowed hostility between Romanism and Protestantism. The difficulty was Gordian-knot like. To send Mary back to Scotland would have alienated that people, and made it a plague of plots; to give her convoy to France would have given the rival claimant of her crown into the hands of the Catholics of the Continent; and to retain her in England was to create a centre for Catholic conspiracies. If Elizabeth, putting herself at the head of Protestantism, defied France, Spain, and Rome, they, remembering the claims and forgetting the crimes of Mary, would seek to supplant her in the sovereign seat, and place her crown on Mary's head. It was a topic ill to handle, and Elizabeth saw nothing for it but patience. It had early been suggested to the Duke of Norfolk that he should marry Mary, and secure a triumph for Catholicism. That scheme, as well as the revolt of the Earls of Northumberland and Westmorland, failed. Alva could give no help. Philip hesitated to undertake an expensive war, and France feared Philip, yet had enough of business on its hand. The Pope's bull came like a declaration of war from Rome, and England both resented his aggressive policy by severe reprisals, and enacted that it was high treason to publish a papal bull, to call the queen a heretic, or to suggest a successor.

The anarchy caused in Scotland by the assassination of the Regent Moray in Linlithgow, 23rd January, 1570, and the renewed plot, suggested by Ridolphi and adopted by Philip, the Pope, and Alva for the restoration of Catholicism by the liberation of Mary and her marriage with Norfolk, made peace at home more desirable to the English, and endeared their queen to them. The Bishop of Ross was put in the Tower. Norfolk was tried, condemned, and beheaded 2nd June, 1572. While Elizabeth was coquetting with the Duke of Anjou, lest France should enter into continental conspiracy, Coligny was gaining influence over Charles IX.'s mind, and as a consequence Henry of Navarre had married Margaret of Valois, 18th August, 1572. Catharine de Medicis was meanwhile plotting the assassination of Coligny. At her instigation Maurevert fired at him secretly, 22nd August. The Huguenots were incensed, the Catholics alarmed. Catharine, when she saw the excitement and perceived so many of the hated sect in Paris, broached the idea of a massacre to Charles. He recoiled, then assented, and rushed hastily to execute it. On the dawn of St. Bartholomew's Day (Sunday), 24th August, the populace of Paris rose, stormed the lodgings of the Huguenots, slew the inmates, and plundered as they proceeded. Only Navarre and Condé were spared. Nearly 20,000 fell in the fanatical outburst of fury as it spread throughout France. Philip laughed at the news; the Netherlands were amazed, and England shocked. The negotiations with the Duke of Anjou were abruptly stayed, and for a time the French ambassador was refused an audience with Elizabeth. A reaction set in. Alva was recalled. France was driven to a policy of conciliation. Charles IX. died in May, 1574; Henry III. succeeded, and few critical circumstances engaged the attention of Europe for some years.

The Protestant cause in Scotland grew stronger, and desiring a closer union with England, they proclaimed—and Elizabeth recognized—James as King of Scotland in 1578. Maitland, in 1573, through fear of Morton, slew himself, and Morton, as art and part in the murder of Darnley, was beheaded by the "maiden," 2nd June, 1581. Lennox and Arran became the king's advisers; but on 12th August, 1582, the Earl of Gowrie, having invited the king to hunt at Ruthven Castle, made James a prisoner. Arran was imprisoned and Lennox banished. The latter died in France, 1583. By a counterplot James was set free, Arran restored to power, and the confederate lords required to flee. In 1585 they, aided by Elizabeth, assembled an army 10,000 strong, with which they stormed Stirling Castle. James capitulated and Arran was banished. Elizabeth had renewed her old policy of balancing opposing interests and putting her neighbours in a dilemma. Against Mary's release she urged the claims of James; against the projects of James she advanced his mother's rights.

For some time the seminary priests—young Englishmen trained first in Douay, then at Rheims, under pledge that when educated they would return to their native land and preach the Catholic faith despite all dangers—began to intrigue against Elizabeth's life. In 1577 the council resolved to enforce against them the penal Acts regarding conformity. Gregory XIII. founded an English College at Rome in 1579, and in 1580 a mission of Jesuits was deputed by him to convert England and carry out therein the bull of 1570. New laws against Catholic training and worship were enacted in 1581, and the denial of the queen's supremacy was declared treason. Many under these Acts suffered terribly for contumacious adherence to their faith. Jesuits and seminary priests were commanded, on pain of death, to quit the kingdom, and an association was formed pledged to avenge any attempt made against the queen's throne or person, and to debar from the crown any one who should authorize, aid, or abet any such attempt. The Prince of Orange had been fired at in 1582, and was assassinated by Belthasar Gerard at Delft, July, 1584. Alexander of Parma was winning in the Netherlands, and only by foreign help could Holland maintain its cause. In January, 1585, the "league" between Philip and the Guises "to prevent a heretic from becoming king of France" was originated, and a plan for the invasion of England through Scotland was projected by its adherents. The Pope, Sixtus V., induced by Dr. William Allen, an English Jesuit, called on Philip to carry out the bull of Pius V., and Philip consented to do so if the succession to the English crown were settled on himself. A plan for the invasion of England by Parma was prepared, and to this a conspiracy for the assassination of Elizabeth was added. Elizabeth was to be consigned to dust, and Mary recalled to empire.

Elizabeth had been frequently importuned to get rid of Mary. She "could not in honour or conscience," she said, "bring an anointed sovereign to the block." But, after Parry's condemnation and execution, Morgan's machinations and Mary's involvement in Babington's conspiracy, under the impulse of self-preservation, she was inclined to reconsider her position. Babington of Dethick in Derbyshire, tempted by Ballard and beguiled by Savage—both urged and guided by the agents of Walsingham—took up the plot, and when everything was matured, he and fourteen of his fellow-conspirators were arrested and arraigned, confessed, and were

condemned. Gifford, Walsingham's agent, was allowed to go to France, but the rest expiated their folly rather than their crime on the scaffold. Burleigh, Leicester, and Walsingham were not long in devising "a ceremonial process for taking away the life of their defenceless captive in as plausible and formal a manner as was compatible with the circumstances." A commission of peers and privy councillors under the great seal—similar to that which formed the *Lords-Triers* in Anne Boleyn's case—was appointed to hold a court in Fotheringay Castle, about two miles and a half from Oundle, in Northamptonshire, to investigate the charges made against Mary. "She appeared," she averred, "not as a criminal to be tried, for she was a sovereign princess, but as a slandered woman to refute the calumnies reported against her"—denying solemnly any complicity in a conspiracy against Elizabeth's life. When she saw how the process was proceeding, Mary demanded to be heard before the Parliament in England or Queen Elizabeth in council. This was disregarded. The court was adjourned. It met 25th October, 1586, in the Star Chamber, Westminster. There and then it declared Mary "guilty of attempting to compass the queen's life," and pronounced sentence of death. Parliament met 29th October, and craved that the sentence be carried into execution. Probably, at first, Elizabeth thought that having Mary's life in her power at any time was victory enough, and that she could pause there. Sentence was intimated to Mary. James sent commissioners to plead on her behalf. Henry III. remonstrated. Elizabeth hesitated. On 1st February, 1587, she signed the death warrant, and Mary, after nineteen years captivity, in her forty-fifth year, was beheaded in the hall of Fotheringay Castle, adhering at once to her protest of innocence and her profession of faith, 8th February.

Elizabeth was appalled at what had been done, and protested that she had never intended Mary's execution. Davison, her secretary, was fined £10,000 and imprisoned. Philip now appeared as the avenger of blood and, as the political chief of Catholic Christendom, threatened chastisement. Pope Sixtus V. renewed Elizabeth's excommunication; made Allen Cardinal and Archbishop of Canterbury, and called adventurers from all parts of Europe to join a holy crusade against schismatic England. Philip—to whom by will Mary bequeathed her claim to England's crown—had been endeavouring to crush Protestantism in the Netherlands. Elizabeth had, after Antwerp's fall, sent Leicester to Holland with help. Parma captured Grave and Neuss; Leicester besieged Zutphen, Parma marched to defend it. Here the chivalrous Sir Philip Sydney was mortally wounded and died 17th October, 1586. Sir Francis Drake had been out on the sea, with a fleet of twenty-five sail, transforming "the Spanish main" into a highway for British enterprise. This could not be endured. Philip designed that Spain should command the sea, and that schism should vanish at the frown of Spain. From the Netherlands on the east and Spain on the south, he would swoop down simultaneously on England, Protestantism should fail, and Britain would be added to the territorial dominion of Spain and the spiritual lordship of the Pope. Drake did what he could at Cadiz and Corunna "to singe King Philip's beard." "The War of the three Henries," then waging in France, caused some hesitation. Yet, as soon as Guise became master of Paris, 12th May, 1588, Philip made ready for the invasion of England. The Invincible Armada—132 ships, rowed by 2088 galley-slaves, manned by 8766 sailors, carrying 300 monks, priests, and inquisitors, and having on board 21,855 soldiers—was got ready at Lisbon. The Spanish troops from the Netherlands would supply 17,000 more men, and conquest was certain. Elizabeth's navy mustered thirty-four ships, carrying 6279 men; but all England rose in the hour of peril, and men, money, and ships were not lacking. Charles Lord Howard of Effingham, as Lord High Admiral, with Drake, Hawkins, and Frobisher under him, saw the Armada wafted up the Channel and chose their time—having now 140 sail. They got to windward, and on Sunday 31st July, began the fight. It grew more intense off the Isle of Wight on the 4th August; on the 7th, while anchored off Calais, eight English fire-ships were set adrift among the Spaniards, they slipped their cables and a storm dispersed them. Only fifty-two shattered ships of all the Invincibles found their way to Corunna, and the Duke of Medina Sidonia bore to Philip in the Escurial the news of complete defeat. On 24th November, 1588, Elizabeth in St. Paul's, gave, with her rejoicing people, thanks to God for this great deliverance, and the medal struck for the occasion bore *Deus flavit et dissipantur.*

Protestantism had been saved both in England and the Netherlands, out of which the Spaniards were driven two years later. Reprisals were made by Sir Walter Raleigh against Spain by expeditions to the American colonies, where he founded Virginia; by attacks on the Spanish coast; and by aid given to Henry IV. of France. The Duke of Guise was assassinated by Henry III., 23rd December, 1588, who was himself slain by Jacques Clement, 2nd August, 1589. In "the wars of the League" Elizabeth assisted Henry of Navarre, who gave Philip II. quite enough to do for some time. The love of naval adventure developed in England, and attacks on Spain became the passion of the age. Norris and Drake led an expedition against it in 1589, and in it Robert Devereux, earl of Essex—who, after the sudden death of Leicester 4th September, 1588, had acquired favour at court—greatly distinguished himself. When the titular King of France, Charles X., died, and it was proposed to place the Infanta Isabella, Philip's daughter, on the throne, that king sent a body of Spanish troops to Brittany against Navarre, and England's anxiety was quickened. On 23rd July, 1593, Henry IV. was received into the Catholic Church; in December, 1595, Pope Clement VIII. solemnly absolved him for the past, and Philip's might began to wane. Even the Holy See felt that Spain's absolute power in Europe would not be an unmixed good. At the capture of Brest, Frobisher got his death-wound, 7th November, 1594. Drake and Hawkins next year received a sea-funeral in the West Indian waters. Philip was building a new armada. A conjoint Dutch and English fleet was sent, under Essex, in 1596, to Cadiz, which was taken and burned. Ireland having been for many years the scene of Spanish intrigues and papal plots, Essex was sent to govern it. For a long time Elizabeth had given it shrewd and strong lords lieutenants; but of late, aided by Philip and the Pope, Hugh O'Neill, earl of Tyrone, had been in open rebellion and set at nought the English forces. On Philip's death, 13th September, 1598, it was thought Tyrone's revolt might be easily put down. Essex sailed for Ireland, March, 1599, but he disappointed everybody. He negotiated with instead of subduing Tyrone, and his enemies reported that he had done so because he wished Tyrone's help in a revolution he aimed at effecting in England. He hurried to London, his task undone and without leave. Having rushed unbidden into the presence of the queen, he was committed to custody, examined by the Star Chamber, and ordered to remain at home during her Majesty's pleasure. He resolved on an appeal to arms against his enemies, and would, in their despite, compel Elizabeth to hear him. The attempt he made to rouse London in his favour failed. This folly was construed as treason. He was tried by his peers and condemned. Elizabeth, who under political pressure had given Norfolk and Mary to the block, could not exercise the prerogative of mercy on behalf of this excuseless rebel. On 23rd February, 1601, at the age of thirty-four, he whom the queen loved like a wayward son was beheaded in the Tower. Mountjoy suppressed the Irish rebellion at great cost of life, treasure, and suffering, though Tyrone was pardoned. The East India Company was founded in 1600. The first Act for the relief of the poor was passed in Elizabeth's last Parliament, and many other reforms were mooted, with the advocates of which it required all her dexterity of intellect to deal. Many of her old advisers had passed away. New complexities were rising round her, and new aims animated the people. She had done her duty, but seemed to have outlived her usefulness. Her isolation grieved her deeply. She had ruled England vigorously, and without much real interest in Protestantism upheld the Protestant interest. Through all the difficulties that beset her path she had passed in triumph, but not unscathed. Men of the most illustrious character had bent to her and served her; admiration and applause had been given un-

grudgingly; but love was not granted to her, and her lonely lot and empty-hearted life grew dismal. Bodily ailments and mental distress combined with political and religious anxieties to weary, worry, and weaken her. In February "she fell downright ill" and "kept her inner lodging," but could not rest in bed. Lying among fringed and broidered scarlet cushions taken from the throne, she suffered much. At length calm came, and about three o'clock in the morning of 24th March, 1603, it was found that Elizabeth had ceased to breathe, in the seventieth year of her age and the forty-sixth of her reign. Under her rule England was stirred by noble aims, and undertook great tasks. Her administration was imperious but wise. She swayed the intelligence of her greatest subjects, and we may well forget some doings worthy of condemnation amid the glory and the worth of the eventful reign of Elizabeth.

THE GREEK LANGUAGE.—CHAPTER XII.

VERBS IN μι—IMPERSONAL VERBS—FORM FOR PARSING GREEK VERBS—EXERCISE IN READING AND PARSING.

Like our own strong or irregular verbs, the Greek verbs in μι are those of the older form, and they have a good many ingrained peculiarities. The statement of these necessarily occupies space and requires a considerable amount of classification of special distinctions. This makes them appear to be much more difficult than they really are to study, remember, and employ. And as they are fewer in number than those weak verbs which receive the name of regular, it is apt to become a fixed idea that they cause more trouble than they are worth. We have done our best, in the compacting of our matter, to reduce the quantity to be studied to its minimum, but we would really be concise where there is most need for giving careful help, if we did not supply some definite aid in the understanding and use of this class of verbs and of the impersonal verbs, as well as indicate some way of enabling the student to register and express in a proper way the parts of verbs when he requires to note or point out the special place in a conjugation they occupy. We provide, in this chapter, some assistance on these points.

We supply first a complete view of the forms which verbs in μι take. The intelligent student will readily, on reference to the following tabular view of all the tense-endings, be able to conjugate the indicative mood in the specific tenses it contains; and by turning to the paradigms of the other moods given on p. 960, he will easily find the tense-endings to be attached to the parts in use in the other moods.

Verbs in νμι take no reduplication, and most usually have the subjunctive and optative of the form in νω; as, δεικνυω, δεικνύοιμι.

1. ἵστημι.

	Act. Pr.	Im.	2 A.	Mid. and Pas. Pr.	Im.	2 A.
Ind.	ημι	ην	ην	ᾰμαι	αμην	αμην
Subj.	ῶ		ῶ		ῶμαι	
Opt.	αιην		αιην		αιμην	
Imp.	ᾰθι		ῆθι		ασο	
Inf.	αναι		ῆναι		ασθαι	
Part.	ας		ας		αμενος	

2. τιθημι.

	Act. Pr.	Im.	2 A.	Mid. and Pas. Pr.	Im.	2 A.
Ind.	ημι	ην	ην	εμαι	ημεν	εμην
Subj.	ῶ		ῶ		ῶμαι	
Opt.	ειην		ειην		ειμην	
Imp.	ετι		ες		εσο	
Inf.	εναι		εῖναι		εσθαι	
Part.	εις		εις		εμενος	

3. διδωμι.

	Act. Pr.	Im.	2 A.	Mid. and Pas. Pr.	Im.	2 A.
Ind.	ωμι	ων	ων	ομαι	ομην	ομην
Subj.	ῶ		ω		ῶμαι	
Opt.	οιην		οιην		οιμην	
Imp.	οθι		ος		οσο	
Inf.	οναι		οῦναι		οσθαι	
Part.	ους		ους		ομενος	

4. δεικνυμι.

	Act. Pr.	Im.	2 A.	Mid. and Pas. Pr.	Im.	2 A.
Ind.	ῦμι	υν	*	ῦμαι	υμην	*
Subj.	—			—		
Opt.	—			—		
Imp.	ῦθι			υσο		
Inf.	υναι			υσθαι		
Part.	υς			υμενος		

* Only ἴσβην (Homer's Iliad, ix. 471), from σβέννυμι, to quench, occurs with a 2nd aorist in class 4.

The other parts of these verbs are, as we have said, formed in the same manner as the similar numbers, persons, tenses, moods, and voices of verbs in ω, and follow the inflexions of the general paradigm. We exhibit the first persons of the other more important parts (1) in the active, (2) in the middle, and (3) in the passive voices :—

(1) Active.

Fut.		1. Aor.		Per.		P. Per.	
Fut.	θήσω	1. Aor.	ἔθηκα	Per.	τέθεικα	P. Per.	ἐτεθείκειν
	στήσω		ἔστησα		ἕστηκα		εἱστήκειν
	δώσω		ἔδωκα		δέδωκα		ἐδεδώκειν
	δειξω		ἔδειξα		δέδειχα		ἐδεδείχειν.

(2) Middle.

Fut.	θήσομαι	Aor.	ἐθηκάμην
	στήσομαι		ἐστησάμην
	δωσομαι		ἐδωκάμην
	δειξομαι		ἐδειξάμην.

(3) Passive.

Per.	τέθειμαι	P.P.	ἐτεθειμην	1. Aor.	ἐτέθην	Fut.	τεθήσομαι
	ἕσταμαι		ἑστάμην		ἐστάθην		στᾰθήσομαι.
	δέδομαι		ἐδεδόμην		ἐδόθην		δοθήσομαι
	δέδειγμαι		ἐδεδειγμην		ἐδειχθην		δειχθήσομαι

It will be of great service in enabling the student to know, when occasion requires it, any special verb he may meet with, and yet not otherwise recognize, to have before him in a concise and orderly *vidimus* a list of all those terminations which are peculiar to verbs of this (μι) conjugation. These are the following, and we note further the particular part of the verb to which each termination belongs :—

μι in 1st, and σι(ν) in 3rd pers. sing. of pres. ind. act.
σαν, in 3rd plur. imperf. ind. and 2nd aor.
θι in the 2nd pers. imperat. pres. and 2nd aorist act.
ην, ης, η, &c., in the optat. of the pres. and 2nd aor. act.
ναι in the infinitive of the pres. and 2nd aor. act.
εις, εῖσα, έν; ούς, οῦσα, όν; άς ᾶσα, άν; ύς, ῦσα, ύν, in the participles of the pres. and 2nd aor. act.

As a general rule—subject, however, to the all-prevailing law of Greek inflexional forms, euphony—these mood and tense terminations are to be added (except in the indicative) to the root with its final vowel shortened, τιθε, ἱστᾰ, διδο.

In the 2nd aor., except in indic., they are to be added to the short root from which they come (θε, στα, δο).

The vowels will, of course, form a diphthong with ι in the optative, and be contracted into ω in the subjunctive.

The infinitive of the 2nd aor. has a long penult; ε, α, ο becoming respectively ει, η, ου or ω.

Ἔστην also retains η in the imperative; and τιθημι, ἵημι, διδωμι, take 2nd aor. imperat., θές, ἕς, δός.

In the participle εντς, αντς, οντς, υντς lose the ν, and so its terminations become εις, ᾶς, ους, ῦς.

In the examples given, and in the rules set forth for the formation of the moods, &c., it must have become plain that these verbs are really distinguished more especially from the previous conjugation by the almost entire absence of the mood-vowels, and that, as a consequence of this, many of the peculiar forms of the tenses have arisen from the combination of the stem with the terminal syllables of the persons of the tenses. In this induction the student is right, and continued thoughtful observation will, as he goes on, make many other changes, euphonic and accentual, perfectly plain.

IMPERSONAL VERBS.

Those verbs alone are, strictly speaking, impersonal which are used only in the 3rd pers. sing., in the infinitive, and the neuter singular and plural of the participle. The following verbs, which it is important to know thoroughly, occur generally in an impersonal form :—

(1) δεῖ, it is necessary.

	Ind.	Subj.	Opt.	Inf.	Part.
Pres.	δεῖ	δέῃ	δεοι	δεῖν	δεον, pl. -οντα
Imp.	ἔδει				
Fut.	δεήσει	—	δεήσοι	δεήσειν	δεῆσον
1 Aor.	ἐδεησε	δεήσῃ	δεήσειε	δεῆσαι	δεησαν

(2) δοκεῖ, it seems.

	Ind.	Subj.	Opt.	Inf.	Part.
Pres.	δοκεῖ	δοκῇ	δοκοῖ	δοκεῖν	δοκοῦν
Imp.	ἐδόκει				
Fut.	δόξει	—	—	—	—
1 Aor.	ἔδοξε	δόξῃ	—	δόξαι	δόξαν

Pas. Perf. δεδοκται, it has been determined, Plup. ἐδεδοκτο.

(3) μελει, it concerns.

Pres.	μελει	μελῃ	μελοι	μελειν	μελον
Imp.	ἔμελε				
Fut.	μελήσει	—	—	μελήσειν	—
1 Aor.	ἐμελησε	—	—	—	—
1 P.	μεμεληκε	—	—	μεμεληκεναι	μεμεληκος
1 Pl.	ἐμεμεληκει				
2 P.	μεμηλε	μεμήλῃ	—	—	μεμηλὸς
2 Pl.	μεμήλει				

Imp. Pres. μελετω. 1 Aor. μελησάτω.

(4) πρεπει, it becomes.

Pres.	πρεπει	πρεπῃ	πρεποι	πρεπειν	πρεπον
Imp.	ἔπρεπε				

(5) χρὴ, it behoves.

Pres.	χρὴ	χρῇ	χρειη	χρῆναι or χρῆν	χρεὼν
Imp.	ἐχρῆν or χρῆν				
Fut.	χρήσει	—	—	—	—

The compound of χρὴ, ἀπόχρη, it is sufficient, gives, besides (plur. ἀποχρῶσι), imperf. ἀπέχρη, fut. ἀποχρήσει, 1st aor. ἀπεχρησε; inf. pres. ἀποχρην, and part. ἀποχρῶν, ῶσα, ῶν. To the foregoing may be added ἀπέχει and ἀρκεῖ, it is sufficient, ἀρεσκει, it pleases, ἔξεστι, it is lawful, προσήκει, it is meet, συμβαίνει, it happens, συμφερει, it is of service, &c.

The following are passive impersonals, ἐνδέχεται, it happens; εἵμαρται or εἵμαρται, and πέπρωται, it is fated.

FORM FOR THE PARSING OF GREEK VERBS.

The student will find it useful to have the following specimen of a pretty full specific form of the parsing of a Greek verb before him, and to employ it as a model:—

τρεφθησεται, a verb from τρεπτω; 3rd pers., sing. numb., 1st fut. tense, indic. mood, pass. voice.

τρεπτω, a verb (in ω) of the First Conjugation.

The 1st fut. of the First Conjugation is formed from the pres. by changing the final syllable into ψω; as τρεπτω, τρεψω.

The perf. act. of the First Conjugation is formed from the fut. by (1) changing ψω into φα; as τρεψω, τρεφα; and (2) by prefixing the reduplication (or the augment for reduplication); as τρεφα, τετρεφα.

The perf. pass. of the First Conjugation is formed from the perf. act. by changing φα, pure, into μμαι (μ doubled); as τετρεφα, τετρεμμαι; τετρεψαι; τετρεπται.

The 1st aor. pass. is formed from the 3rd pers. sing. of perf. pass. (1) by changing αι into ην; as τετρεπται, τετρεπτην; (2) by changing π, τ into their aspirates φ, θ; as τετρεπτην, τετρεφθην; and (3) by taking away the letter of reduplication; as τετρεφθην, ἐτρεφθην.

The 1st fut. pass. is formed from the 1st aor. pass. by (1) changing ην into ησομαι; as ἐτρεφθην, ἐτρεφθησομαι; and (2) by casting off the augment; as ἐτρεφθησομαι, τρεφθησομαι, τρεφθησει (or ῃ), τρεφθησεται; *i.e.* the specimen word.

When, by study, a greater familiarity with the verb has been attained, the following shorter form will be sufficient:—

τρεφθησεται, a verb from τρεπτω; 3rd pers., sing. numb., 1st fut. tense, indic. mood, pass. voice.

τρεπτω, a verb (in ω) of the First Conjugation.

Fut. τρεψω, perf. act. τετρεφα, perf. pass. τετρεμμαι, 1st aor. pass. ἐτρεφθην, 1st fut. pass. τρεφθησομαι, τρεφθησει (or ῃ), τρεφθησεται.

EASY LESSON IN READING AND PARSING.

THE BEATITUDES.—Matthew v. 3–10.

3. Μακαριοι[1] οἱ[2] πτωχοι[14] τῳ[2] πνευματι,[13] ὁτι[3] αὐτων[5]-ἐστιν[31] ἡ[2] βασιλεια[6] των[2] οὐρανων.[9]

4. Μακαριοι οἱ πενθουντες,[20] ὁτι αὐτοι[4] παρακληθησονται.[24]

5. Μακαριοι οἱ πρᾳεις,[19] ὁτι αὐτοι κληρονομησουσι[28] την γην.[12]

6. Μακαριοι οἱ πεινωντες[21] και[29] διψωντες[22] την δικαιοσυνην,[8] ὁτι αὐτοι χορτασθησονται.[27]

7. Μακαριοι οἱ ἐλεημονες,[18] ὁτι αὐτοι ἐλεηθησονται.[25]

8. Μακαριοι οἱ καθαροι[15] τῃ καρδιᾳ,[7] ὁτι αὐτοι τον Θεον[10] ὀψονται.[26]

9. Μακαριοι οἱ εἰρηνοποιοι,[16] ὁτι αὐτοι υἱοι[11] Θεου[10] κληθησονται.[23]

10. Μακαριοι οἱ δεδιωγμενοι[17] ἑνεκεν[30] δικαιοσυνης,[8] ὁτι αὐτων ἐστιν ἡ βασιλεια των οὐρανων.

The following parsing vocabulary gives the words arranged in their relations as parts of speech. The sentences are all pretty simple, and the syntax of them is plain. Read with the translation, which is in everybody's hands, the student should find the passage easily understood.

[1] Nom. plur. mas. of μακαριος, ια, ιον, from μακαρ, blessed (not as the mortal but the eternal are—Homer in Iliad i. 339, and Odyssey ix. 299).

[2] Different cases of def. art., for which see p. 480.

[3] Causal conj. that, for, because; originally neut. of ὁστις, ἡτις, ὁτι.

[4] Nom. and [5] gen. plur. of adj. pron. αὐτος, &c. See p. 479.

[6] Nom. sing. fem. of βασιλεια, ας, [inherited] kingdom.

[7] Dat. (of inhering quality) sing. fem. of καρδια, ας, heart, affection, mind.

[8] Gen. and acc. sing. fem. of δικαιοσυνη, η, righteousness.

[9] Gen. plur. mas. of οὐρανος, ου, heaven (of eternal bliss).

[10] Gen. and acc. sing. mas. of Θεος, ου, God.

[11] Nom. plur. of υἱος, ου, a son.

[12] Acc. sing. fem. of γη, γης, the [habitable] earth.

[13] Dat. (of inhering quality) sing. neut. of πνευμα, ατος, life, spirit.

[14] Nom. plur. mas. of πτωχος, η, ον, poor, humble.

[15] Nom. plur. mas. of καθαρος, α, ον, [morally] pure.

[16] Nom. plur. mas. of ειρηνοποιος, ου, peacemakers.

[17] Nom. plur. mas. of δεδιωγμενος, η, ον, persecuted; perf. part. pass. of διωκω, ωξω, to choose.

[18] Nom. plur. mas. or fem. of ἐλεημων, ονος, merciful, from ἐλεεω.

[19] Nom. plur. mas. of πρᾳὺς, εια, υ, mild, meek, gentle.

[20] Nom. plur. mas. of πενθων, ουσα, ον, pres. part. of πενθεω, I mourn.

[21] Nom. plur. mas. of πεινων, ουσα, ον, pres. part. of πειναω, I hunger.

[22] Nom. plur. mas. of διψαν, ουσα, ον, pres. part. of διψαω, thirst for or after.

[23] 3rd pers. plur. 1st fut. pass. of καλεω, I call, invite.

[24] 3rd pers. plur. 1st fut. pass. of παρακαλεω, I cheer, I make glad.

[25] 3rd pers. plur. 1st fut. pass. of ελεεω, I pity, pass. obtain mercy.

[26] 3rd pers. plur. 1st fut. of irreg. verb ὁραω, I see (from stem οπτ), ὀπτομαι, ὀψομαι, ὀψαμην.

[27] 3rd pers. plur. 1st fut. pass. of χορταζω, I satisfy (with).

[28] 3rd pers. plur. 1st fut. of κληρονομεω, I obtain (as an inheritance).

[29] Copulative conj., and. Generally placed before the connected word.

[30] A prepositional adverb, governing gen., for the sake of.

[31] 3rd pers. sing. pres. indic. of the subs. verb ειμι, I am. In each of the beatitudes εισι(ν), are, is understood after μακαριοι.

CHAPTER XIII.

INDECLINABLE PARTS OF SPEECH—CONJUNCTIONS.

THE indeclinable parts of speech are in Greek distinguished by the general name of particles. They are (1) Adverbs (including Interjections), (2) Conjunctions, and (3) Prepositions.

ADVERBS are either (1) primary, as νυν, now, τοτε, then; or (2) derivative in (*a*) στι, as ἑλληνιστι, in Greek, ωμαιστι, in Latin; (*b*) δον, as κυνηδον, like a dog; (*c*) ην, as κρυβδην, secretly; (*d*) ει, as πανσυδει, altogether, entirely; (*e*) αξ, as ὀδαξ, with the teeth.

(1) Adverbs are added to verbs, adjectives, and other adverbs to define and qualify more particularly the attributive signification of the words to which they are joined.

Derivative adverbs are for the most part formed from nouns, adjectives, particles, verbs, and prepositions.

From the genitive plural of a noun-adjective an adverb in ως is derived: as των ἀληθων, ἀληθως, truly; των ὀξεων, ὀξεως, sharply.

The syllabic additions (*a*) δε, σε, ζε, denote *to* a place; (*b*) θεν, θε, *from* a place; (*c*) θι, σι, χου, χη, *in* a place: as οὐρανονδε, to heaven; ἐκεισε, thither; ἐραζε, to the earth; οὐρανοθε, from heaven; παντοθι, πανταχου, πανταχη, everywhere, anywhere.

These adverbial prefixes—Ἀρι, ἐρι, ἀγα, βρι, δα, ζα, βου, λα, λι, increase the signification of the words to which they are added: as δηλος, manifest, ἀριδηλος, or ἐριδηλος, very manifest. The syllables νη and νε in composition have generally a privative force: as νηπιος, without speech; νεπους, without feet; though sometimes, but seldom, they increase the sense; as νηδυμος, very sweet; νηχυτος, widely flowing.

Εὐ as a prefix gives the sense of (*a*) excellence or praise; as εὐειδης, fair; εὐοσμος, sweet-smelling; (*b*) facility, as εὐκινητος, easy to be moved; (*c*) happiness, as εὐγαμος, happy in marriage; but (*d*) sometimes it diminishes the sense of the compound; as εὐωρος, negligent; εὐτελης, of little worth.

Δυς implies the reverse of εὐ in all the foregoing significations; as δυσειδης, ugly; δυσοσμος, ill-scented; δυσκινητος, hard to be moved; δυσγαμος, unhappy in marriage.

The prefix ἀλφα imparts a (*a*) privative, (*b*) conjunctive, or (*c*) intensive force; as χαρις, grace, ἀχαρις, ungrateful; παντες, all, ἀπαντες, all together; ξυλον, wood, ἀξυλος, full of wood.

Neuter adjectives are often used as adverbs.

Some derivative adverbs govern the case of their primitives; as ἀξιως ἡμων, in a manner worthy of us; ὁμοιως τοις ἀλλοις, similarly to the rest.

Adverbs, as well as all other indeclinable words (including infinitives), may be used as nouns by having the neuter article or a preposition prefixed to them; as το νυν, the now, *i.e.* the present; εἰς ἁπαξ, for once; το περαν, the other side, &c.

Some adverbs, especially those of time, place, and quantity, govern the genitive; as ὀψε της ἡμερας, late in the day.

Adverbs which in signification approach to the nature of prepositions also govern the genitive; as λαθρα του ἀνδρος, without the knowledge of her husband (Lat. *clam marito*). A few, like ἀγχου, ἀλις, ἐγγυς, ὁμου, σχεδον govern also the dative; as ἀγχι τῳ ὑδατι, near the water, &c.; ἁμα governs the dative only; as ἁμ' ἡγεμονεσσι, together with the leaders.

A preposition is sometimes expressed along with the genitive and dative; as μεχρις ἐτ' ἐμου, as far as me; ἁμα συν αὐτοις, together with them.

In Greek an adverb may even be employed to qualify a noun; as ἡ παραυτιχ' ἡδονη, the instantly (felt) pleasure; ὁ ἐντος ανθρωπος, the man within, *i.e.* the inner man; εν τῳ τοτε χρονῳ, at that then (=very) time.

Adverbs derived from adjectives are for the most part compared by using the accusative singular neuter of the comparative, and the accusative plural neuter of the superlative of their derivatives; as

σοφως, wisely,	σοφωτερον,	σοφωτατα.
αἰσχρως, basely,	αἰσχιον,	αἰσχιστα.

The following adverbs derived from prepositions are compared by τερω and τατω:—

ἀνω, upward,	ἀνωτερω,	ἀνωτατω.
κατω, downward,	κατωτερω,	κατωτατω.
πορρω, far; Dor. σω,	πορρωτερω, σιον,	πορρωτατω, σιστα.
προσω, forward,	προσωτερω,	προσωτατω.
ἐνδον, within,	ἐνδοτερω,	ἐνδοτατω.
ἀπο, from,	ἀπωτερω,	ἀπωτατω.
ἑκας, far,	ἑκαστερω,	ἑκαστατω.
ἐσω, within,	ἐσωτερω,	—
ἐξω, without,	ἐξωτερω,	—

The adverbs undergiven have irregularities in their comparison—

εὐ, well,	βελτιον,	βελτιστα.
μαλα, greatly,	μαλλον,	μαλιστα.
πολυ or πολλα, much,	πλειον, πλεον, πλειν,	πλειστον. πλειστα
ἀγχι or ἀγχου, near,	ἀσσον, ἀσσοτερω, or ἀγχοτερω,	ἀγχιστα. ἀγχοτατω.
ἐγγυη, near,	ἐγγιον, or ἐγγυτερω or ον,	ἐγγιστα. ἐγγυτατω.
ἡκα, gently, in a very small degree,	ἡσσον, less,	ἡκιστα, least.
ὀψε, late,	ὀψιαιτερον, ὀψιτερον,	—

The particle κις is added to the neuter of adjectives to express the divisions of time; as πολλα, often, πολλακις, oftentimes; πεντακις, five times; ποσακις, how often.

Such Greek constructions as the following may be rendered adverbially in our tongue—viz. προς οργην, angrily; προς βιαν, violently; προς ὑβριν, insolently; προς ὑπερβολην, excessively.

CONJUNCTIONS are either—

(1) Copulative; as και and τε, and; ἠδε and ἰδε (in the poets), and; και μεντοι, and also; και μην και, moreover; και τοι και, and further; και γαρ αὐ, again also.

(2) Adversative; as καιπερ, εἰ και, κἀν, although.

(3) Distinctive; as μεν, indeed; δε, but; γε, ἀταρ, ἀλλα, at least, but; μεντοι, truly, but; μεντοι που, μεντοι γε, yet truly; δεγε, δεπου, δετοι, but; δε δη, but now.

(4) Disjunctive; as ἠ, ἠτοι, ἠπου, or, either, whether.

(5) Conditional; as εἰ, with its compounds ἐαν, ἀν, ἠν, if; περ, εἰδη, εἰδηπερ, if in truth; ἐπειπερ, ἐπειδη, ἐπειδηπερ, ἐπειουν, ἐπειη, if, when, after, since; εἰ δ' ἀρα, but if.

(6) Causal; as γαρ, και γαρ, ἠ γαρ, γαρτοι, γαρπου, γαρ δηπου, for, for truly; οὐ γαρ ἀλλα, for not; ὁτι, διο, διοτι, καθοτι, οὑνεκα and ὁθουνεκα (in the poets), because; ἐπει, since; ἱνα, ὡς, ὁπως ὀφρα (in the poets), ὡστε, that.

(7) Rational; as οὐν, ἀρα, οὐκουν, τοιδη, τοιγαρτοι, τοιγαρουν, τοινυν, και δη, τοὐνεκα (in the poets), wherefore, therefore; οὐκουν, not therefore.

(8) Dubitative; as ἀρα, is it so? μων, is it at all?

(9) Exceptive; as ὁμως, δηπου, γεδηπου, εμπης, yet; ἀλλα γαρ, ἀλλα δη, ἀλλα μην, ἀλλ' οὐν, but, but yet, but truly; ἀλλα γε οὐν, but certainly at least; ἀλλα δη και, moreover also.

(10) Potential; as ἀν and (in the poets) κε or κεν.

(11) Expletive. These, although they appear, when translated, to be redundant, yet have each in Greek their own force and sense, and though occasionally it is somewhat difficult to determine exactly what these are in equivalent English phraseology, yet their effect is clearly perceptible to the skilled scholar. Among them are ρα, κεν, νυ, που, τοι, περ, πω, &c.

(12) Negatives; as οὐ (or οὐκ) and μη. The former is direct, denying without reference to anything else; the latter is conditional dependent; as Οὐ ληψομαι, εἰ μη συ κελευεις, I will not take unless you order. In expressing fear μη signifies lest; as Δεδοικα μη τι παθοι, I fear lest he suffer anything.

Two negatives generally strengthen the negation; as Ου μη σε ανω, ουδ' ου μη σε καταλιπω (Heb. xiii. 5), I will not leave thee, nor forsake thee. So Xenophon, at the close of his apology for Socrates, his master and friend, finely says, Εγω μεν δη κατανοων του ανδρος την τε σοφιαν, και την γενναιοτητα ουτε μη μεμνησθαι δυναμαι αυτου, ουτε μεμνημενος μη ουκ επαινειν, Contemplating the wisdom and magnanimity of that man, I am neither able not to remember, nor remembering, not to exalt him.

The greater number of conjunctions introduce the proposition with which they are connected; but the following never stand at the beginning: αὐ, again, moreover; ἀρα, therefore, fittingly, of course; γαρ, for; γε, at least; δαι, then; δε, but, and; δη, verily (in prose); δηθεν, forsooth; μεν, indeed; οὐν, therefore; τε, and; τοι, therefore.

μεν and τε stand after that word which is opposed to another; ἀρα circumflexed is interrogative: whethe.? is it so?

ENGLISH LITERATURE.—CHAPTER XIV.

POETRY AND THE DRAMA: SECTION I. POPE TO GOLDSMITH—SECTION II. OTWAY TO ADDISON AND STEELE.

The poetic name and fame of Pope have been the theme of much debate. The battle between Bowles and Byron concerning him excited lively interest early in the present century. As an artist in words, Pope's powers are consummate, but they do not flush with emotional life, and so display race and grace. His was an age of artificiality, was polished, ceremonious, censorious, but neither very healthy in character nor hearty in intellectual energy. As a poet, Pope moulded the best thinking of his time into the most tasteful forms. He imparted a subtle ductility to language Dainty elegance and dapper finicality prove him unrivalled in the perception and practice of true taste in writing. The felicity and grace of his early poems he continued to exhibit even to the last. His genius was chastened by criticism, and perhaps some of its charm was lost through the prevalence of introspective watchfulness, while perhaps the reflex influence of his own personal unshapeliness gave intensity to his conviction of the value of the perfect outward form which he painstakingly endeavoured to impress upon his poems.

Alexander Pope was born in Lombard Street, London, 21st May, 1688. His father, a prosperous linen-draper, after he had married Edith Turner, soon retired from business with £20,000, and settled at Binfield, near Windsor Forest. Their son was weakly, deformed, and stunted. He had the short body of a hunchback, and therefore looked as if he had prodigiously long arms. He was precocious, and learned rapidly.

> "Bred up at home, full early I begun
> To read, in Greek, 'The Wrath of Peleus' Son.'"

His school training ended at twelve. At this age his "Ode on Solitude" was composed. About the same time he began to write an epic, poem on "Alexander, Prince of Rhodes." In the last year of Dryden's life he got a glimpse of that poet. His "Pastorals," after being handed about in MS. for four years, were published in 1709. In 1711 the "Essay on Criticism" appeared. Addison proclaimed it "a masterpiece of its kind," and indeed for melody of verse, felicity of expression, judgment, and wit it is justly admired. Boileau's "Art of Poetry" had been rendered into English by Sir William Soane, and had the advantage of revision by Dryden; Horace's "Art of Poetry" and an "Essay on Translated Verse" had been published in 1680 by Wentworth Dillon, earl of Roscommon; and John Sheffield, duke of Buckinghamshire, had issued his "Essays on Poetry and Satire." But the young poet, while praising these authors, excels them. He says and shows that

> "True wit is nature to advantage drest—
> What oft was thought, but ne'er so well expressed."

His next effort—an exquisite example of persiflage and poetry—won him unquestioned repute. Lord Petre had, in a gallant mood, snipped off a lock of Mrs. Arabella Fermor's hair. The frolic was resented, and a quarrel ensued. It was suggested that Pope might laugh the families into good humour. Thus "The Rape of the Lock" was begun. It appeared in two cantos in 1712 in Lintot's *Miscellanies;* but the author soon resolved on making it a mock-heroic epic. It was reissued in 1714, enlarged to five cantos, and the delicate deliciousness of the work augmented by the introduction of the fanciful machinery of sylphs and gnomes. In 1715 a new edition was issued, with a playful key interpreting it as a satire of Queen Anne's Barrier Treaty, furnished by the poet, under the signature of "Esdras Barneveldt, Apoth." "Windsor Forest" was published in 1713—the year of the peace of Utrecht, which the poet eulogizes. It contains the following forecast of free trade:—

> "The time shall come when free as seas and wind
> Unbounded Thames shall flow for all mankind,
> Whole nations enter with each swelling tide,
> And seas but join the regions they divide,
> Earth's distant ends our glories shall behold,
> And the *New World* launch forth to meet the *Old.*"

Swift, in 1713, reported that "the best poet in England was Mr. Pope, a papist, who had begun a translation of Homer into English verse." Chapman, Hobbes, and Ogilby had preceded him, and he was largely aided by their labours in getting at the meaning of the fine simple Greek of the old Scian Bard, but at first he had terrible trouble in crystallizing the resonant hexameters into happy heroics. His perseverance enabled him to finish the first part of his undertaking, the "Iliad," in 1720, in a style of verse matchless in its melody, though as a translation it exhibits little of what Christopher North designated the "stormy sunshine" of the Achilleid, and if it embalms it also entombs much of the magnificent minstrel's meaning. The "Odyssey" he did in great part by proxy—using Broome and Fenton as his helpers, but revising their labours and keeping in tone the music of the lyre. As Addison cautiously said, "Homer's immortal poem appears to as little disadvantage in this as Virgil's Æneid did in Dryden's version." Pope edited the poems of Parnell, and undertook an edition of Shakespeare, by the reception of which he was chagrined and mortified. He resolved on repaying his critics by a satire. Dryden was his model, and his "Dunciad" is certainly only second to "MacFlecknoe." It is vigorous and spirited in versification, but not unfrequently decency and propriety are sacrificed to effect. Pope preluded this celebrated stinging satire by his "Treatise on Bathos" (1727). The first edition of "The Dunciad"—in three books—appeared in 1728; the second, annotated, in 1729. In 1742 he added a fourth book called the "New Dunciad," and in 1743 an altered version was issued with Cibber instead of Theobald as the hero, but as the whole book was not revised to suit this change the satire lost its bitingness. Lord Bolingbroke, learning Pope's desire to compose a philosophical poem, drew out a scheme of thought—greatly derived from the "Theodicea" of Leibnitz—for the bard of Twickenham, and the author acknowledged him as guide, philosopher, and friend at the close of "The Essay on Man" (1732–34), which resulted from this copartnery. Pope's "Moral Essays" and "Imitations of Horace" appeared within the next three years. He fell into declining health, and on 30th May, 1744, imperceptibly expired. His verse is pungent and precise, yet simple, his thoughts apt and accurate, and he is a master in perfect propriety of expression and of rhythm, but there is little that is grand or generous in his poetry. In temper he was rather touchy, and his quarrels were consequently frequent. He exhibited a good deal of craft, and practised chicanery with effect. With neither a great loving soul nor an expansive genius, he had worldly wisdom, and supplied wit to the world expressed in harmonious phraseology, quotable and proverblike, though neither profound nor spirit-soaring.

Thomas Parnell—the son of a Commonwealth man of Congleton, Cheshire, who went over to Ireland under the Cromwellian settlement—was born in Dublin in 1679. He entered Trinity College, Dublin, at the age of thirteen, was M.A. in 1700, and, under dispensation, was ordained deacon by the Bishop of 'Derry. In 1705 he was made Archdeacon of Clogher, and married Miss Anne Minchin. Parnell, though trained a Whig, attached himself to the Tory party, and Lord Oxford in his case was pleased to forget the statesman in the friend. He became popular as a preacher, but sought excitement in drink. His two sons died young, and his wife died in August, 1712. He was, at Swift's solicitation, made a prebendary in Dublin in 1713, and vicar of Finglass in 1716. While on his way to Ireland in July, 1717, he died at Chester, and was buried there in Trinity Church. Pope speaks of him as learned and good-natured, exceedingly pleasant in conversation, and very generous. Goldsmith, writing on the authority of his father and brother, who knew Parnell, describes him as a capable man, uneven in temperament, always in extremes of agony or rapture, too ready to throw upon chance and fortune the blame of self-created wretchedness, and yet it is said that he

> "With sweetest manners gentlest arts adorned."

Sprightly airiness and graceful gaiety mark his best efforts. He expresses the happiest thoughts in the simplest style. It would be difficult to equal, still less to surpass, the happy

harmony of his language. His "Hermit," though long before his day

"A tale to prosemen known, by versemen famed,"

is a favourite with the general reader, and is approved by all; his "Fairy Tale" is an excellent reproduction of the old English ballad style; "Hesiod, or the Rise of Woman," tells the story of Prometheus and Pandora in gay and ready lines; and many of his translations are appropriate, well-reproduced, and agreeable transfusions of classic conceptions into English expressions. Without any specific poetical genius, Parnell has done some few things excellently well, and many with taking simplicity and unpretendingness.

Ambrose Philips (1671–1749) composed pretty pastorals, which Pope lampooned and Gay burlesqued. In 1712 he transformed Racine's "Andromaque" into "The Distrest Mother," and produced the two tragedies, "The Briton" and "Humphrey, Duke of Gloucester" in 1722. John Philips (1676-1708), in "The Splendid Shilling," in mimetic Miltonic verse, produced the finest burlesque of the age; "Cider" he modelled on the "Georgics," and nearly reached his aim. His "Blenheim" did not equal Addison's "Campaign." While engaged on a poem on "The Last Day" he was cut off by consumption, 15th February, 1708, aged thirty-two.

The painfully romantic life of Richard Savage (1698–1743), as presented to us in that mournful record of the glory and the gloom of genius, Dr. Johnson's "Lives of the Poets," is not only far more poetical and far better remembered than his plays or poems. The strength and finish of "The Bastard" must be admitted, and while the provocation which roused him into passion cannot be excused, its spirit cannot be admired. "Sir Thomas Overbury," a tragedy, "Love in a Veil," a comedy, and "The Wanderer" contain singularly forcible lines, exhibit choice thought and diction, though often harsh and intemperate. William Somerville (1692–1742) in his "Chase" (1735) and "Field Sports" (1742) celebrates "the image of war without its guilt," and the amusements of falconry, fishing, &c., resonantly. "Hobbino" is a racy burlesque of more than ordinary verse. They are all lively and readable. The Rev. John Dyer (1700–58) devotes great ingenuity and a fascinating style to the landscapes seen and the interests evoked by "the care of sheep and the labours of the loom" in the four books of "The Fleece" (1727). His "Grongar Hill" is pleasing and varied. His "Ruins of Rome" (1740), records of ideas induced by a visit to Italy, do not maintain their writer's reputation. Matthew Green (1697-1737) put wit, wisdom, and poetry into his "Spleen" (privately printed in 1732). William Shenstone (1714–63) of Leasowes has put exquisite feeling and appropriate sentiment into his "Pastoral Ballad;" a peculiar charm is conveyed in "The Schoolmistress" by the contrast between the stately Spenserian verse and the lowly lot of the heroine. This has always been a favourite, and his "Judgment of Hercules" (1741) is a moral poem founded on a parable related by Xenophon. William Falconer, a grocer's son in Edinburgh, born 1732, was

"Forlorn of heart by Fate's severe decree,
Condemned reluctant to the faithless sea,"

published "The Shipwreck" (1762), and perished when the *Aurora* foundered in the Channel of Mozambique in 1769. Charles Churchill (1731) is the most notable of the English satirists between the days of Pope and those of Byron. His "Rosciad" (1761) was an immediate and striking success. It was followed by "The Apology" and by "Night." These and "The Ghost," "The Candidate," "The Times," "Independence," &c., are all marked by strong expression and stout wit. Churchill died at Boulogne on 4th November, 1764.

The genius of Gay (1688–1732) was not great, though quaint and original. This smart, sleek, ex-silkmercer is best remembered now by that slight song which Jekyl parodied and Jerrold dramatized, "Black-eyed Susan," and those "Fables" in verse which were written for the instruction of William, duke of Cumberland, who figures in history at Dettingen, Fontenoy, and Culloden. His chief work is "The Beggar's Opera" (1727), which Swift suggested, and against which Thomas Herring, archbishop of Canterbury, preached. This take-off of the Italian opera "made Rich (the manager) gay and Gay rich." By his "Rural Sports" (1711) he introduced himself to Pope, who became and remained his friend. Pope said that he was

"Of manners gentle and affections mild;
In wit a man, simplicity a child:
With native humour tempering virtuous rage,
Formed to delight, at once, and lash the age."

The rusticity of "The Shepherd's Week" (1714) and the Cockney farcicality of the "Trivia" (1715) are a sort of good-humoured luxury of laziness to read. They have a rare charm of humanity of a softish sort about them. Gay gave to the stage "The Wife of Bath" (1713), "What d'ye Call It?" (1714) "Three Hours after Marriage" (in which Pope helped him, 1717), "Dione," a pastoral tragedy (1720), and "The Captives" (1723). Handel set his serenata "Acis and Galatea" to music 1732. He was a friend of Allan Ramsay's, and Burns' "Jolly Beggars," if not directly from Gay, yet indirectly from the old song "The Merry Beggars," is due to Gay's opera, in which Peachum (Jonathan Wild), Macheath, Filch, Mat o' the Mint, and others compact into singularly condensed verse the very quintessence of satire, though unfortunately the vice is scrabbled o'er with pleasantry. The swing of the verse is lively:—

"When you censure the age,
Be cautious and sage
Lest the courtiers offended should be;
If you mention vice or bribe,
'Tis so pat to all the tribe
That each cries, That was levelled at *me!*"

Swift's vehement spirit and intense but disappointment-racked nature made him rejoice in mischief. He strove so strongly, yet so signally failed; fought so fiercely and was so fatally foiled, that commiseration for his cares and perplexities, his lapses into vanity and from sanity, his struggles, trials, desperation, and defiance even of defeat, restrains condemnation of his cynicism. His intellectual energy was gigantic, excursive, and suggestive. It overmastered men. He "had stiffness of will, but his morals were limber." A punster once said "he was subject to influences *stellar* and lunar, but both were *evanescent*." His life holds matter for a dozen novels. As a poet he never attempted the pathetic or sublime, but frolicsome burlesque and familiar caricature he manages admirably. He is original, passionate, and purposeful rather than poetic. His rhymes are prompt and facile; his thoughts quick and virile; his imagination distinct and accurate, and with him words always fall into their proper places. Purity and delicacy were not much valued in his age: he regards them little; and his unrivalled irony is often poison-tipt. It is much to be regretted that a nobler life, devoted to nobler objects, was not lived by him, for the records of his triumphless intrigues are sad to read. His verses, it must be remembered, were almost all occasional, and thrown off with rapidity and *abandon* of extemporaneousness for attaining some present end, not for gaining future fame. It is impossible, and it would be unprofitable to try, to catalogue or criticise them in detail. There "are not more degrees from elephants to mites in cheese" than may be found in them. They range from riddles and rebuses to epitaphs and epigrams; verses made for fruit-women to verses sent to ladies, lords, and prelates; parodies to prologues; fables to pastorals; ballads to elegies; and birthday rhymes to patrons' praise in odes. They are seldom read; and when they are, selections are pretty requisite, exquisite though the hits of such wits may be.

Edward Young (1681–1765) was fifty years old when, entering the church, he became rector of Welwyn, Hertfordshire. Educated at Winchester and at Oxford, he graduated LL.D. in 1719. He liked peers and poets, and passed the greater part of his life as a courtier, suggesting as grounds for his claims to gracious favour "abilities, good manners, services, age, want, sufferings, and zeal for his Majesty." His grandiose and unripe poem on "The Last Day" (finished 1710) was issued in 1713. He unduly employed the pale horse of the Seer of Patmos as the pegasus of a courtier. In "The Force of Religion, or Vanquished Love,"

exemplified in Lady Jane Grey and Lord Guildford, he dealt with historic life, but he soon ventured again upon awful solemnities in paraphrasing the speech of the Almighty in the Book of Job xxxviii.–xli., as a piece of fine dramatic "fiction founded on truth." In this he dilates and dilutes the simplicity of Scripture into stagey rodomontade. He contested an election at Cirencester in 1721, and between 1725 and 1728 issued in folio *fasciculi*, "seven characteristical satires" on love of fame as the universal passion, full of acute observation, polished wit, effective raillery, urbane humour, and ingenious pleasantry. In his two "Epistles to Mr. Pope" on the authors of the day, he is piquant and pointed, but general and impersonal in such apothegms as these—

> "With fame, in just proportion, envy grows:
> The man that makes a character makes foes."
>
> "Nothing but what is solid or refined
> Should dare ask public audience of mankind."
>
> "Time is the judge; time has nor friend nor foe;
> False fame must wither, and the true will grow."

It is in his "Night Thoughts," too often dark from excess of light, that his verse has real poetical rhythm, his sentiments force and eloquence, and his imagery boldness and originality. But not unfrequently the apparatus of darkness (which, as in a magic lantern exhibition, helps to bring out the pictures) imparts an artificial ghastliness to the torch funereal and the nodding plume, the churchyard with its relics of the dead, in contrast to the jarring world and its vigour and interest, and makes that look big to thought which is only so by trick of style. Both the divinity and the poetry acquire a spectral magnificence and strikingness from the exaggeration of the gloom. The bard of grief is too fond of epigram, the minstrel of meditation too mournful in his tone, and too seldom on these "Night Thoughts" does the "Dayspring from on high" arise. Having served the church forty years at his college living in Welwyn, Young, after protracted ill-health and a fortnight's severe illness, expired 5th April, 1765.

Quite a different divine singer was John Norris (1657–1711), the mystic Platonist who, forty-seven years after George Herbert's death, again gave philosophic thought and poetic power a place in Bemerton pulpit. He was one of those fine intelligences which—to use his own words—"like angels' visits, short and bright," come among men to open up glimpses of "the ideal or intelligible world." This metaphysical ecclesiastic was a controversial power against Tindal and Dodwell, follower of Malebranche, critic of Locke, friend of Arthur Collier, and precursor of Berkeley, preacher of sermons full of good sense and subtle thought, daintily-worded, and powerful in expression. Norris, in the multiplicity of his gifts and the voluminousness of his works, has been almost forgotten as a poet—pure and serene in his penetrative insight into human feeling, and exquisitely effective in putting wise thoughts into familiar words. What a fine human yearning he puts into Adam's heart as he is being "turned out of paradise:"

> "Stay, then, bright minister, one minute stay,
> Let me in Eden take one farewell round,
> Let me go gather but one fragrant bough,
> Which, as a relic, I may keep and show;
> Fear not the tree of life; it were
> A curse to be immortal, and not here!"

To the proud wealthy clown, possessor of a spot of earth beneath the notice of the geographer, he says—

> "I can enjoy what's yours much more than you;
> Your meadow's beauty I survey,
> Which you prize only for its hay;
> There I can sit beneath a tree,
> And write an ode or elegy.
> What to you care, does to me pleasure bring,
> You own the cage, I in it sit and sing."

William Collins was a bard of exceptional power, but, too intensely overwrought, his fine intelligence was eclipsed by insanity. Born in 1721, he tells us, "The classic streams with early thirst I sought." "He was full of great plans. He would write tragedies, produce a history of the revival of learning," but dreamed of, rather than worked himself into, greatness. His eclogues and odes are favourites with all poetic minds. They are skilful, nervous, elegant, and quick-thoughted. The "Ode to Evening" is tranquil, and a mild diffusive light brightens it. In the "Ode to the Passions" condensed intensity is conspicuous, and few contrasts can be greater than the reposeful tenderness of the "Ode on the Death of Thomson" and the rapt inspiration of the "Ode on the Superstition of the Highlands." His dreams and dissipation ended in darkness and death, 12th June, 1759.

James Thomson, born 7th September, 1700, was the son of the minister of Ednam, Roxburghshire. Educated at Jedburgh and Edinburgh, he—discarding theology for poetry—ventured to London with his poem "Winter" as all his wealth. Millar bought it at a low price, but as it gained the approval of Thomas Whateley, then (and even yet) of note as a critic, it was published (1726), and rapidly passed through edition after edition. Next year, while acting as tutor to Lord Binning, "Summer" was issued, and his poem "To the Memory of Sir Isaac Newton" (who had died 20th March, 1727) appeared in June. His "Britannia," though written in that year, was not published till 1729. "Spring" was published in 1728, and his tragedy of "Sophonisba" was put on the stage in 1729. "The Seasons"—"Autumn" having been added—were issued in a complete edition in 1730, having a hymn given as an epilogue. It forms a volume almost equally effective on the reader's reason, imagination, and taste. In subsequent issues several exquisite passages were omitted, and no fewer than 5541 lines were altered, so carefully did this singer endeavour to condense "the mazy running soul of melody into his varied verse." Thomson was invited to go the grand tour with Charles Richard Talbot (1730–31), and on his return he chose as a topic for his muse "Liberty," which was originally issued in five parts (1734–36). It is a poetico-philosophical attempt to trace the progress of freedom from the first ages to his own time, and reproduces some of those ideas and suggestions excited by his travels and gathered on classic ground. It seems to have been chilled into formal coldness by this classic choice. On the 6th April, 1738, "Agamemnon" was unfavourably received on the stage, yet within a month 3000 copies were sold, and a new edition of 1500 was immediately taken up. "Edward and Eleonora" (1739) was refused a license owing to its political allusions, but being printed in 1740 had a great run. In conjunction with Mallet, Thomson wrote, in 1745, "The Masque of Alfred," which contains the national lyric "Rule Britannia;" "Tancred and Sigismunda," the most successful of his tragedies, was performed with great applause in May, 1748; "The Castle of Indolence" was published, and shortly afterwards his "Coriolanus" was finished. The author expired 27th August, 1748, from a chill which passed into a fever. In describing the changing beauties of the changeful year, Thomson

> "Informs the page
> With music, image, sentiment, and thought
> Never to die."—"*Summer.*"

In the "Seasons" his diction is florid and "amusive," and here and there the blank verse is tumid; but every ennobling association is inwrought with his felicitous sketches, and morals and religion are never forgotten. In his plays, there are many fine resonant lines and exquisitely expressed sentences, though characterization—varied as the elements—is defective. In "The Castle of Indolence" luxurious serenity and sage old-fashioned monotonousness of life impress us, at once, with sweet repose of thought and energy of soul. With what a fine, quiet, soft, endearing, personal charm Lord Lyttleton has invested the poet's personality!—

> "A bard here dwelt more fat than bard beseems,
> Who void of envy, guile, and lust of gain,
> On virtue still and Nature's pleasing themes
> Poured forth his unpremeditated strain;
> The world forsaking with a calm disdain,
> Here laughed he careless in his easy seat;
> Here quaffed, encircled with the joyous train;
> Oft moralizing sage! his ditty sweet
> He loathèd much to write, ne carèd to repeat."

Allan Ramsay, a native of the lofty Lanarkshire village of Leadhills, where he was born 15th October, 1686, was apprenticed to an Edinburgh wigmaker in the year of Thomson's birth, and issued his pleasant pastoral, "The Gentle Shepherd," in the very year that Thomson passed from Leith to London. Ramsay's unique "hodden-gray" drama was an instantaneous success. Homely simplicity, rustic innocence, pawkie humour, good sense, honest thought, and a certain air of everyday life, make the pulse brisk and quick while reading it. It took both town and *ton*, and quite a tremor of joy was felt at the revelation made in it. Common experience contains the most genuine poetry, if hearts are true and homes are holy. The barber bookseller, printer, poet, and publisher—a quaint, antique, humorous, and kindly spirit—enlivened the Canongate and found fame and fortune. Gay, Pope, and Somerville were his friends. So were the two Hamiltons—of Bangour and of Gilbertfield; and in his shop—the sign of Jonson and Drummond—the noble, the wealthy, the learned, and the witty met and talked. He built a theatre in Carruber's Close—a license for which was refused—and a house on Castle Hill. He died 7th January, 1758. His minor poems have the spirit and ease of Horace, his songs are Scotland's best prior to Burns, his fables and tales are humorous and garrulous — sometimes indelicate in expression; but the shepherd life about "Habbie's Howe," with "a trotting burnie wimpling through the ground," is a delineation as perfect and pleasing, pure, though playful in manners and unaffected in form, as has been drawn in any nation's drama.

John Armstrong (1709–79) was born at Castleton, Roxburghshire, graduated in medicine at Edinburgh, and by "The Art of Preserving Health" (1744), gained a high place among didactic poets. In style, it is classic like Milton's, with something of the diffuseness of Thomson. It contains many judicious precepts, and is adorned by several images of beauty and power. His "Benevolence" (1751) and "Taste" (1755) have fewer good points, and are more jejune. His only tragedy, "The Forced Marriage," Garrick thought unfitted to compete with Mrs. Behn's, having the same title, on the stage. He attended Thomson on his deathbed, visited Smollett in his last illness, and died from the results of a carriage accident. Another physician, Mark Akenside, made his *début* as a didactic poet in 1744. Pope declared he "was no ordinary writer." This scholar and wit, born in Newcastle-upon-Tyne, 9th November, 1721, was educated at Edinburgh as a Presbyterian minister, and graduated at Leyden as a doctor of medicine, 16th May, 1744. "The Pleasures of Imagination" is a poem of great promise and much power. Though written in felicitously fluent phrase, his blank verse has a sonorous amplitude which often seems too vast for the subject, and affords more pleasure to the ear than to the heart. His view of mind is animating and grand, but he scarcely hints at any hope beyond the grave; his odes are overstrained alike in adulation and in condemnation, and he never acquired the lively lightness of the lyric poet. He died 23rd June, 1770. There are few poems in which the language and images are so appropriate, natural, and picturesque as that of the "The Grave," published in 1743 by Rev. Robert Blair of Athelstaneford. Through his friend Colonel Gardiner (who was killed at Prestonpans, 1745) this poem was brought under the notice of Dr. Watts, and by his influence it was accepted by the booksellers. It was long held in high esteem by the serious and devout in Scotland, where it had an immense sale as a chap-book. Its author was a scientific student, an able preacher, and on his gloomy theme he has produced the most Shakespearian ideas and the most Miltonic verse of any poet of his century. He died 4th February, 1746. His successor in the incumbency of Athelstaneford was John Home, a native of Leith, born 22nd September, 1722. In his rural manse, he composed "Douglas, a tragedy," which was in 1756 brought on the stage of the Canongate theatre, Edinburgh, and caused an uproar of excitement and delight. The chivalrous valour, romantic generosity, and eagerness for fame of Young Norval, the long-cherished sorrow and maternal tenderness of Lady Randolph, and the fine rural images used by Old Norval, no less than the simple realism of the story and the easy flow of the dramatic dialogue, charmed the crowd. This alarmed the clergy, and they instituted proceedings against the author. He resigned his charge and went to London, where he brought out "Ægis" (1758), a play in poetry and pathos little inferior to "Douglas," first entitled "Rivine," but by David Garrick thus named after an anonymous play performed a century before; "The Siege of Aquileia" (1760); "The Fatal Discovery" (1769); "Alonzo" (1773); and "Alfred" (1778)—all somewhat inferior to "Douglas." Home died 5th September, 1808, aged eighty-six.

Goldsmith was only two years old when Thomson wrote to Bubb Doddington from Paris (1730): "It seems to me that such a poetical landscape of countries [*i.e.* one as seen with the Muse's eye], mixed with moral observations on their government and people, would not be an ill-judged undertaking. But then the description of the different face of nature in different countries must be particularly marked and characteristic, the poetical painting of nature." This is a prophetical forecast of "The Traveller"—that early deliberate endeavour after enduring fame which the imagination of Goldsmith first sketched as a footsore flute-player in Switzerland in 1755, and laid before the public as "the first work to which he prefixed his name," after having waited the Horatian nine years, in 1764. During his lifetime it passed through nine editions. Its language is rich, yet not over-ornate, and musical though simple. His feelings are tender, his fancy delicate, his pencil picturesque, his allusions beautiful; they link, by magical associations, things of everyday with ideas at once grand and sublime. Without laborious subtlety it is chastely skilful, and imparts refined delight. "The Deserted Village" appeared in May, 1770, and ran through six editions before the year closed. Its pathos and simplicity endear it to the heart, its sympathetic sensibility makes it sacred to the imagination, and even although some may hesitate to accept its philosophy of life, few can resist the fascination of his spirit-stirring strains, their exquisite rhythm, their mellow music, and their charming charity and considerateness. Fame has acknowledged him great alike for his novels, satires, comedies, essays, and histories, but she places on his brow the laurel of the poet with no grudge, and oft she quotes the splendid sentences with which he has enriched "our English," *e.g.*—

> "Learn the luxury of doing good."

> "Creation's heir—the world, the world is mine!"

> "How small, of all that human hearts endure,
> That part which laws or kings can cause or cure;
> Still, to ourselves, in every place consigned,
> Our own felicity we make or find."

> "Ill fares the land, to hastening ills a prey,
> Where wealth accumulates and men decay."

> "Self-dependent power can time defy,
> As rocks resist the billows and the sky."

Goldsmith's comedies are the most admirable of those which survive from the days of Anne and the early Georges. The fashionable plays of the period have perished. The public appetite was palled with the capering hilarity of vice; but Goldsmith's "Good-natured Man" and "She Stoops to Conquer" are innocently humorous, brilliantly gay, sprightly in character, and interesting in plot. George Coleman's "Jealous Wife" (1761), founded on Fielding's "Tom Jones" and "The Clandestine Marriage" by Garrick and Coleman; Richard Cumberland's "West Indian" (1771), "Wheel of Fortune," and "Fashionable Lover;" Hugh Kelley's "False Delicacy" and "School for Wives;" and Richard Brinsley Sheridan's "The Rivals" (1775), "School for Scandal" (1777), and perhaps "The Critic"—in which Cumberland appears as Sir Fretful Plagiary"—may be quoted as approaching more nearly to the amusive manner of Goldsmith than the abusive style of Samuel Foote (1721–77).

SECTION II.—OTWAY TO ADDISON AND STEELE.

After the Puritan party, in 1643, gained the upper hand in London, no toleration was given to the stage. Even

> "The sweat of learned Jonson's brain
> And gentle Shakespeare's easier strain"

were inhibited. The theatres were closed. At the Restora-

tion, they were reopened, and Dryden then became the chief purveyor for the stage. Sir Walter Scott rightly describes his heroic plays as "metrical romances in the form of dramas." His comedies are broadly marked with conspicuous license, strained wit, and French declamatoriness. Either growing taste or the urgency of poverty induced him to forsake the continental fashion and return to British forms. He abandoned rhyme, betook himself to blank verse, and made an effort to restore the Shakespearian ideal to the stage.

Among the contemporaries of Dryden, who was undoubtedly the chief of the Restoration dramatists, were the three sons of Sir Robert Killigrew—(1) Sir William Killigrew (1605-93), author of four tragi-comedies, "Pandora, or the Converts" (1664), "Ormasdes, or Love and Friendship" (1665), "Selindra" (1665), and "The Siege of Urbin" (1666), issued in a folio volume 1669. "The Imperial Tragedy" is also attributed to him. These were all acted with applause. His two volumes of (233) "Artless Midnight Thoughts of a Gentleman at Court," who for many years "built on sand, which every blast of cross-fortune has defaced, but now he has laid new foundations on the Rock of his salvation," contain some quaint moral reflections. (2) Thomas Killigrew (February 1611 to March 1682), who attended Charles II. in exile, and during this time was, unofficially, the king's jester. After the Restoration, he was appointed censor of the king's theatre. He wrote eleven plays, of which two, "Claricilla" and "The Prisoners," having been acted at the Phœnix, Drury Lane, were published in 1641, while the others, of which "The Parson's Wedding"—written in Basel and all acted by women—is the best, were published in a folio in 1664. His "Bellamira," "Thomaso," and "Cecilia" are each in two parts. Sir John Denham sarcastically says—

"Had Cowley ne'er spoke and Killigrew ne'er writ,
Combined in one they'd made a matchless wit."

(3) Dr. Henry Killigrew (1613-90), subsequently Master of the Savoy, though the youngest brother, seems to have been the first to tempt the stage. He was but seventeen when, on the occasion of the marriage of Lord Charles Herbert with Lady Mary Villiers, daughter of the Duke of Buckingham, he produced "The Conspiracy," a tragedy which won the commendations of Ben Jonson and Lord Falkland. It was published without his consent in 1638, but he issued a revised edition in folio in 1653, under the title of "Pallantus and Eudora." Dryden's fine elegiac ode "On Mistress Anne Killigrew, excellent in the two sister-arts of poesy and painting," refers to Dr. Henry Killigrew's beautiful and accomplished daughter, who died of small-pox, 1664.

Of another family, three members of which expended great pains to win dramatic renown, Lord Macaulay somewhat harshly says, "The poetry of the Berkshire Howards was the jest of three generations of satirists." The mirth began with the first representation of "The Rehearsal" (by George Villiers, duke of Buckingham, 1671), and continued down to the last edition of the "Dunciad" (1742). Sir Robert Howard was the original hero of "The Rehearsal," and was called Bilboa. In the remodelled "Dunciad" Pope inserted the lines—

"And high-born Howard, more majestic sire,
With Fool of Quality completes the choir."

Pope's "high-born Howard" was Edward Howard, author of the "British Princes" (a heroic poem, 1669).

(1) Sir Robert Howard, who was of the family of Thomas Howard, viscount Andover, first earl of Berkshire (1626)—whose daughter, Elizabeth, Dryden married—produced, in conjunction with his brother-in-law, "The Indian Emperor" (1667), being a sequel to "The Indian Queen," a tragedy in heroic verse, which had been acted with great success, the music being by Purcell, in 1664. In this same year the noble author placed on the stage "The Surprisal," a tragicomedy, and "The Committee, or the Faithful Irishman," a comedy (written to ridicule the Puritan party) which gained great applause. In 1668 he produced "The Great Favourite, or the Duke of Lerma," intended, Pepys says, as a reproach to the king for his looseness of life. To "The Vestal Virgin, or the Roman Ladies," in imitation of Sir John Suckling's "Aglaura" (1637), the author composed two closing acts, the one sad, the other merry, so that it might be performed either as a tragi-comedy or a true tragedy. The plot of the "Blind Lady" is founded on an incident in Peter Heylin's "Cosmography," and the humour depends on an old lady who is willing to run the risks of marriage for the seventh time. Though Shadwell, being of the opposite party, satirized him in "The Sullen Lovers" as Sir Positive At-all, and his wife as Lady Vain, Howard was really a man of parts, of whom Dryden said—

"In your head
The curious net that is for fancies spread,
Lets through its meshes every meaner thought,
While rich ideas there are only caught."

He translated Virgil (book fourth), Statius' "Achilles," and wrote "Historical Observations on the Reigns of Edwards I., II. and III., and Richard II." (1689); "A History of Religion" (1694), and several rather clever poems (1696). (2) The Hon. Edward Howard (Sir Robert Howard's brother) produced in January, 1663-64, "The Usurper," a tragedy in which Damocles (according to Thomas Hobbes) represents Oliver Cromwell, and Hugo de Petra Hugh Peters, who was executed as a regicide (1660). "Six Days' Adventure" (1671), and "The Man of Newmarket" (1678), comedies, and "The Woman's Conquest" (1671), a tragi-comedy, have been printed; but "The Change of Crowns" (1667), highly successful in representation, "The London Gentleman" (1667), and "The United Kingdoms," have not been published. He is the author besides of "Poems and Essays" (1674). (3) His youngest brother, Hon. James Howard, in December, 1667, placed on the stage "All Mistaken, or the Mad Couple," and "The English Monsieur." Both of these were esteemed good comedies, and Lady Wealthy in the latter was one of Nell Gwynne's famous characterizations. He likewise altered Shakespeare's "Romeo and Juliet," preserving the lovers alive, and making them happy in each other.

Thomas Otway was born at Trotten, in Sussex (1651). Educated at Westminster School, and Christchurch College, Oxford, he became first an actor, then a playwright. In 1675 he produced "Alcibiades," a plotless and shadowy tragedy in rhymed couplets. It was a partial failure, yet Betterton next year accepted "Don Carlos." This story of "an untamed, haughty, hot, and furious youth," was written in sinewy, swinging verse. It won applause from crowded audiences, and sneers from Rochester, who furnished the poet with a model for some parts of "Don John." The poet was enriched and enraptured. Next, he translated Racine's "Titus and Berenice," and Molière's "Cheats of Scapin." In a fit of despairing love for Mrs. Barry, Otway accepted a cornet's commission under the Duke of Monmouth, and flew to fight in Flanders, leaving behind him a comedy entitled "Friendship in Fashion," which, when produced, was highly successful. It is repulsive, naughty, and dull; but it was thought to be a lampoon, and the town laughed. On his return, after the peace of Nimeguen, Otway, ragged, starving, and unpaid,

"Full of those thoughts that make the unhappy sad,
And by imagination half grown mad,"

produced "The Soldier's Fortune," to which Lord Falkland wrote a prologue. Otway's "Orphan" was the literary sensation of 1680. Mrs. Barry's exhibition of Monimia's miseries drew tears from every eye. The plot turns upon an unpleasant, improbable incident—taken from the history of Brandon in a novel entitled "English Adventures," which had been published in 1667—but the characters are drawn with vigour and with sustained power. In "Caius and Marius" Otway took his materials, not from Plutarch's "Lives" and Lucan's "Pharsalia" only, but very largely too from "Julius Cæsar" and "Romeo and Juliet." In the prologue, speaking of Shakespeare, Otway admits

"He's rifled him of half a play;
Amidst his baser dross you'll see it shine
Most beautiful, amazing, and divine."

Marius junior and Lavinia are modelled after the ill-starred lovers of Verona, and Sulpitius is Mercutio done not

in porcelain but in delft ware. Many portions spoken by all three are taken verbatim from the elder dramatist. The author had evidently in his mind's eye the factions of Charles II.'s reign while he wrote of the contentions between Sylla and Marius. In "The Poet's Complaint to his Muse" Otway supplies some autobiographic account of himself, and vents denunciations on Rochester, Shadwell, and Settle. He had "fallen on evil days," and subsisted by the bounty of the Duchess of Portsmouth. But when he next appeared as a playwright he rose to his full strength in "Venice Preserved," and made the nearest approach to the Shakspearian stage-play which the intervening century affords. The plot is excellent and the construction of the scenes admirable, the characters forcibly conceived and originally drawn, and the verse ebbs and flows with the passions of the speakers. Though a little embued with the passing patriotism of the period when Titus Oates' story of a "Plot Discovered" touched men's hearts with tremor, it needs no such adventitious aid, and it would be greatly bettered if it wanted the nauseous lechery of Antonio—intended as a satire on the Earl of Salisbury. The creation of such an exquisite piece of womanhood as Belvidera has secured an immortality of fame. This tragedy revived the stage in 1682. In 1684 Otway's latest play, "The Atheist," a continuation of "The Soldier's Fortune," was placed on the boards. He made a great effort to produce "Windsor Castle" (1685)—a bid for the patronage of James II.; but, before the fruition of his hope, want and drink brought his life's tragedy to an end. He died at the Bull, a dirty alehouse in Tower Hill, 14th April, 1685, when only thirty-four.

Thomas Shadwell (1640–92), as the wearer of the laureate's wreath, has been unduly ridiculed. He chose Ben Jonson for his model, but he had not Jonson's "immortal substance," and spoiled his own vivacity and wit by carelessness in composition and sensuality in life. His plays, crude and hastily written (sometimes one in a month) under the stimulus of opium, are dramatic in structure, and as pictures of the humours or manners of the age not ill drawn, though his heroic verse is often "mature in dullness." Of his seventeen plays none supply inviting reading, and only through dearth of books or the sternness of duty could any mortal man undergo the penance of perusing them. Many of them, though not destitute of good sense, deal with disagreeable doings, and are so full of cant and slang as to require a glossary. He was the Whig rival of Dryden when the latter was a Tory. Unfortunately he was impaled as MacFlecknoe by his foe, and the delight of laughter at him has been prejudicial to fair judgment of him. Elkanah Settle, designated by Dryden "Doeg, whom God for mankind's mirth has made," has been laughed at rather than with. His verse is duller, and his plays, though quite as numerous, are even more thoroughly dead than Shadwell's. It is not easy to see how his stilted rant and tumultuary plots could have been "held in high esteem both with the court and town," as "Cambyses" (1671) and "The Empress of Morocco" (1673) were. The latter was burlesqued by Thomas Duffet in 1674, and a controversy, engaging the pens of Dryden, Shadwell, Crowne, and its author stirred the literary world. John Crowne (died 1703)—son of a Nova Scotian dissenting minister—was patronized by Charles II. At his suggestion he imitated the Spanish comedy "No puede ser" (It cannot be) in "Sir Courtly Nice," in which Hothead and Testimony satirize Tory and Whig pretty impartially. In his "City Politics," Shaftesbury, Sir William Jones, College, Titus Oates, and others are severally mimicked. His comedies, especially "The Country Wit," are somewhat amusing, but his tragedies, the best of which are "Thyestes" and "The Destruction of Jerusalem," are entirely undramatic and extremely involved. He died in obscurity. Nathaniel Lee (1655–91) not only trode the stage in the same year as Otway, but, while scarcely twenty, had his "Nero" played. It, as well as some other of his eleven tragedies (mostly classical), contains some fine "translunary things" and a great deal of bombast. Self-indulgence, working on a brain overstrained, brought him to bedlam. His "Alexander and Theodosius" kept their place long on the boards. Thomas Southerne (1659–1746) has been successful in "Isabella, or the Fatal Marriage," and in "Oroonoko"—founded on Mrs. Behn's novels "The Nun" and "Oroonoko;" and he may be said to have originated the anti-slavery agitation which was only closed by the recent civil war in America. The tears of Isabella to this day water Southerne's laurels.

In the great days of the drama, when it was instructive and poetical, it was beneficial that before an unreading public the stage should

> "Let gorgeous tragedy
> In sceptred pall come sweeping by;"

but George Lillo (1693–1739), a jeweller in London, thought it would be well to bring the powers of such an agency "home to men's business and bosoms." With this intent he devoted his leisure hours to the composition of domestic dramas designed "to hold the mirror up to nature" for some useful purpose. The first, "George Barnwell" (1731), founded on "a ballad of a London apprentice, who thrice robbed his master, and murdered his uncle," was so successfully realistic that for upwards of half a century it was played on Boxing-night as a useful warning to the youths of London. Pelham, in his "Chronicles of Crime," records that a gentleman who had for many years sent £10 on his benefit night to David Ross, a celebrated impersonator of Barnwell, left him a legacy of £1000 because he had been conscience-stung by this play. The second, "Fatal Curiosity" (1736), is based on an incident narrated in Dr. Franklin's "Annals of James I. and Charles I." (1681), of a son returning from the Indies, who visits his love Charlotte, and, asking lodging from his father without revealing who he was, intrusts his stepmother with a casket of jewels, and retires to rest. She opens the casket, instigates the father to murder him, and he does so. When Charlotte tells who he was, old Wilmot kills his wife and himself. Henry Mackenzie, half a century afterwards, altered it into "The Shipwreck." Besides plays entitled "Scanderbeg" and "Elminek," he produced an opera, "Sylvia," and left a drama on "Arden of Faversham" unfinished. This was completed by Benjamin Hoadley, M.D., author of "The Suspicious Husband" (1747), a very excellent vivacious comedy, in regard to which Macklin produced a farce entitled "The Suspicious Husband Criticized, or the Plague of Envy." Lillo's verse is easy, level, choice, and expressive, his sentiments excellent, but his plots are sensational and disagreeable. Edward Moore (1712–57), a London linen-draper, son of a Nonconformist minister of Abingdon, following Lillo, produced a severe and caustic exposure of the domestic misery caused by the passion for play in "The Gamester." Dr. Young thought highly of it. Moore wrote "The Foundling" and "Gil Blas" (two unsuccessful comedies), "Fables for the Female Sex," and edited *The World*, to which Lords Chesterfield and Lyttelton and Horace Walpole were contributors. Dr. Edward Young, before taking orders, composed "Busiris, King of Egypt" (1719), and "The Revenge" (1721). The latter holds high rank as a splendid tragedy, and even yet Zanga's sufferings—a father's death, his own defeat, captivity, deprivation of the crown, and, worst of all indignities, a blow—enlist the sympathy excited by the woes of a lofty and impatient spirit, one of those

> "Souls made of fire, and children of the sun,
> With whom revenge is virtue."

One might wish that the comedy of the Restoration and the Revolution could be by some means disinfected. Its easy grace, riant gaiety, exuberant wit, frank familiarity, and delicious fun, have never since been equalled; but unfortunately these are combined with so much grossness and indelicacy, licentious intrigue and grinning sensualism, that "none but itself can be its parallel." Without denying that manly common-sense expressed in racy English, and idiomatic persiflage uttered with exquisite nonchalance, abound in them, it is equally impossible to deny that flippant indecency of conversation and flagrant libertinism of incident form their staple. One of the most gentlemanly of those too faithful transcribers of the vices and manners of these times was William Wycherley, born at Cleve, in Shropshire, 1640, educated in France (where he was received into the

Roman Catholic Church), and trained in philosophy and law at Oxford (where he was readmitted to the English communion). He became a student in the Middle Temple, and a man about town. His first comedy, "Love in a Wood, or St. James's Park," was brought out in May, 1669. It was dedicated to the Duchess of Cleveland, by whom he was introduced to Charles II., who took him into his favour. The "Gentleman Dancing Master" appeared in 1671, "The Plain Dealer" in 1674, and "The Country Wife" in 1678. Shortly afterwards, the recently widowed Countess of Drogheda, going into a bookseller's for "The Plain Dealer," was introduced to Wycherley as the real plain dealer. They were privately married; but when she died, leaving all her property to him, he was involved in lawsuits, ruined, and imprisoned. James II. paid his debts after he had lain seven years in jail, and when he had returned to the Romish faith. "Placing matrimony after extreme unction," as Pope says, he married a young lady whose fortune of £1500 enabled him to pay his debts, and gave her in exchange his name and a jointure of £400, much to the dismay of his nephew and heir. He died December, 1715.

Sir George Etheridge replaced the comedy of whimsicality with that of intrigue. He was the most polished wit and distinguished dramatic writer of Charles II.'s reign. Ease, liveliness, and good sense characterize the highly-coloured copies of the cavalier caste which he places before the audience; but most of them have constitutions injured by debauchery, fortunes wrecked by play, and minds of ingrained libertine habit. They have dash, and go, and show. Their address is easy and their conversation unreserved; marriage is with them a mode, and seduction a fashionable amusement. He belonged to an Oxfordshire family, was educated in France, and trained to the law. "The Comical Revenge, or Love in a Tub," "took the town" in 1664. It was followed by "She Would if She Could," in 1668. This play Addison castigates in the *Spectator*, No. 51. "The Man of Mode," in 1676, displayed in Dorimant the witty Earl of Dorset and Wilmot, earl of Rochester, rolled into one, and several of the other sprightly rakish wits and sparks among his contemporaries. Sir Fopling Flutter was taken as a portrait of himself. He died in 1688.

William Congreve admired, copied, and modelled himself after the manner of Wycherley. He was the son of Richard Congreve, of Congreve, Staffordshire, but was born at Bardsea, near Leeds, about 1672. He was educated at Kilkenny and in Dublin University, and joined the Middle Temple in 1690. Dryden declared he had never seen a first play so full of genius and so deservedly successful as "The Old Bachelor," which was represented in 1693. Captain Bluff, to whom "fighting is meat, drink, and cloth," and Sir Joseph Wittol bear marks of Congreve's study of Ben Jonson, and his liking for Bobadil and Master Stephen. Heartwell's amorous passion, whimsical delirium of folly, and poignant sarcasm of speech, the polite libertinism of Bellmour, the impotent doting of Fondlewife, the arch coquetry of Belinda, the humorous difficulties of Vainlove, and the veneer and starch of Lord Plausible, make up a bill of fare in which the sauce and sauciness exceed the solids. "The Double Dealer," which was acted next year, is better in its dramatic power, and worse in its morality, than its predecessor. There are in it three rakes, and Sir Paul Pliant is perhaps the most reprehensible picture of a father ever placed upon the comic stage. The solemn Lord Froth, who thinks "nothing more unbecoming a man of quality than to laugh," and the silly Lady Froth, authoress of "The Syllabub," a heroic poem, who pretends to poetry, learning, and wit, are charmingly ridiculous. "Love for Love" (1695) in plot and characterization is one of the best in the language; but its principal female characters, except Angelica, are vicious and heartless. Sir Samson Legend, a testy malignant wit, tries to disinherit his elder son Valentine in favour of his seafaring son Ben, much given to the talk of the forecastle; Tattle is an empty-headed, talkative coxcomb; Scandal performs his duty as a moralist with a plentiful lack of good-nature and good-humour. Angelica befools Sir Samson, the father, and confers her fortune and hand on Valentine. In "The Way of the World" (1700) matrimonial infidelity is his topic. Millamant is an exquisite example of feminine vivacity and sprightliness; she "loves to give pain because cruelty is a sign of power," and Mirabel—said to be a piece of self-portraiture—who loves her with all her faults, nay for her faults, wins her. But the plot is intricate, and the byplay disagreeable. Between the two last-named comedies Congreve produced in 1697 his single tragedy, "The Mourning Bride," Almeria, who on the day of her private marriage to Alphonso, prince of Valencia, is separated from her husband by shipwreck. Alphonso, under the name of Osmyn, is taken as a captive to Grenada, where he finds Almeria. Osmyn is terribly tempted by the intense love of Zara, an African queen; but he escapes, raises an army, and marches to Grenada. Both Manuel, the king, and Zara are by that time dead, and "the mourning bride" is rejoicingly rejoined to Alphonso. An operatic oratorio of Congreve's "Semele" was set to music by Handel. Congreve was esteemed and befriended by men of both parties. Even playwrights made him arbiter in their squabbles. He gained the favour of the Marlboroughs and places worth £800, and gave up the drama for real life. "The ladies loved him," says Thackeray, "and he was undoubtedly a pretty fellow. His plays are full of wit; but ah, it is a weary feast that banquet where no love is. It palls very soon, and indigestions follow it, and lonely blank headaches in the morning."

George Farquhar (1678-1709) has been called "the Fielding of the drama." He is full of animal spirits and boisterous glee, and his stock-in-trade as a comedian is pretty fairly hinted at in his first farce-like comedy, "Love and a Bottle" (1698). He may be said to carry the drum among dramatists. All he does is loud and striking. He is more surprising even than diverting. He was an Irishman (born at Londonderry), and a lieutenant of Foot. "The Constant Couple" came out in 1700, and its sequel, "Sir Harry Wildair," in 1701; "The Inconstant," Mirabel (who dallies, not "in the innocence of love," with Oriana)—a degraded reproduction of Beaumont and Fletcher's "Wildgoose Chase"—(1703); "The Stage-coach" (1704), "The Recruiting Officer," Sergeant Kite (1706), and "The Beau's Stratagem," written on his deathbed (1707). In them all gallants and demireps display loose passions, low humours, fashionable vices, and potter about in a continuous hurry of shabby plots and unworthy intrigues, which excite mirth at the expense of morality.

Sir John Vanbrugh (1666-1726) was of Flemish lineage, English birth, and French training. He was a well-employed architect by profession, of respectable private character, "a wit, and a man of humour." Of the architect of Blenheim Palace and the transformer of Greenwich Hospital, the epigrammatist has said—

> "Lie heavy on him, earth, for he
> Laid many heavy loads on thee."

Heavy though his buildings may be, his wit is light, sprightly, airy, familiar, and prolific. In six or seven months he placed three comedies on the stage; but they were chiefly borrowed from Molière — viz. "The Cuckold in Conceit" (Cocu Imaginaire), "Squire Trelooby" (Monsieur de Pourceaugnac), and "The Mistake" (Dépit Amoureux). Of the other eight plays he wrote, the best are "The Provoked Wife" (1697), which shows up the brutality, ill-manners, and neglect which too frequently led to intrigue and sin; "The Relapse, or Virtue in Danger," a sequel to Colley Cibber's first play, "Love's Last Shift" (1692), in which Vanbrugh retained all the principal characters, and maintained their style and air with ease and graceless grace; and "The Confederacy" (from Dancour's "Bourgeoises à la Mode"), exhibiting varied scenes of life and character, remarkable for want of principle. "Esop" is a comedy in two parts, the plot of which is taken from a French play produced about six years previously by Edmonde Boursault, although Sir Polidorus Hogstye, the beau, the senator, and the players are added by Sir John, and the denouement has been altered. Colley Cibber took up "The Journey to London," left unfinished by Vanbrugh, and brought it out as "The Provoked Husband," a companion to Sir John's first play. When stirred by the

state of the theatre to issue his "Short View of the Immorality and Profaneness of the English Stage" (1697-98), Jeremy Collier severely censures Dryden, Congreve, Otway, and Vanbrugh. The latter immediately issued a short vindication of "The Relapse" and "The Provoked Wife" from immorality and profaneness (1698). Congreve, Settle, Dennis, Drake, and even Wycherley (it was suspected) assailed the nonjuring bishop, and Edward Filmer, D.C.L.—who in 1697 had given to the stage "The Unnatural Brother," a tragedy founded on Seigneur de la Calprenede's romance, "Cassandra"—issued "A Defence of Plays" (1707). The ecclesiastical historian was a capable controversialist who had the courage of his opinions, and he bated no jot of his acrimony, ire, and argument. There can be no doubt that the work of this "master of the rhetoric of honest indignation" had a wholesome effect on the theatrical productions of subsequent times, and this improvement the essays and examples of Steele and Addison encouraged and stimulated in "The Conscious Lovers."

Sir Richard Steele's first dramatic production, "The Funeral, or Grief à la Mode," was played in 1702. It is a masterpiece of comedy made attractive by wit without immodesty, and humour with virtue. "The Tender Husband" followed next year. It contained many applauded strokes from Addison's beloved hand, and Mrs. Oldfield made Biddy Tipkin an immortal love-lorn Parthenissa. In the "Lying Lover" (1704), he had the temerity to place the slashing divine, whose "short view" of the drama was so pointedly severe, on the stage, and long afterwards, in the House of Commons, he averred that this comedy was unsuccessful on account of its piety. The most carefully written and most successful of his comedies, "The Conscious Lovers," which Fielding's Parson Adams regarded as "the only play fit for a Christian to see, and as good as a sermon," did not appear till 1722, shortly before his retirement to Llangunor, where he died 21st September, 1729.

Joseph Addison's "Cato" (1713) excels in dialogue and dignified declamation. It was planned and partly written while he was travelling on the Continent. He hesitated long to finish it, but when produced it won applause from all parties. It ran through three editions in ten days, and was almost immediately translated into French, German, and Italian. Two years afterwards, his comedy "The Drummer," founded on a legend of Hurstmonceaux House, proved his possession of wit and the possibility of being sprightly and merry without profanity or license. His opera, "Rosamond," a bright, light, melodious trifle, being set to music in 1706, inaugurated the English opera. Dr. Johnson was in every sense so great, especially in common-sense, that we are surprised at his affording an instance of "The Vanity of Human Wishes" (1749), on finding that he, the author of "London" (1738), had cherished the idea of becoming a dramatic writer. He had hugged the ambition in his soul from the time when, while schoolmastering it at Edial, he penned the singularly monotonous blank verse of his tragedy "Irene," placed by Garrick on the stage in 1749, after nearly twenty years' waiting, although in 1708 Mr. Charles Goring had printed his (unacted) "Irene, or the Fair Greek," a tragedy. But Johnson was a noble-souled struggler, whose life was a real tragedy of trial and triumph.

David Mallet (Malloch), born at Crieff in 1700, has won more regard by his simple, pleasing ballad of "William and Margaret," published in Aaron Hill's periodical, *The Plain Dealer*, No. 36, in 1723, than by his poem, "The Excursion" (1728), his satire, "Verbal Criticism," levelled at the distinguished Greek scholar Richard Bentley, in his tragedies "Eurydice" (1731), "Mustapha" (1739), and "Elvira" (1763). To be looked upon without pain, Mallet's career requires the faith of his wife or the flattering gift of Chesterfield, who said, in reference to his "Truth in Rhymes," eulogistic of Lord Bute and George III.,

> "It has no faults, or I no faults can spy,
> It is all beauty, or all blindness I."

George Villiers, duke of Buckingham—born at Wallingford House, Westminster, 30th January, 1627, second son of the murdered duke—eager, as he averred, to expose folly, pedantry, false reason, and ill writing, taking his cue from Beaumont's "Knight of the Burning Pestle," produced the famous burlesque of "The Rehearsal" about 1663, though it was not produced till 1671. With the help of "Hudibras" Butler, Mr. Martin Clifford, master of the Charterhouse, and Thomas Sprat, his chaplain—author of poems on "The Death of Oliver Cromwell" and "The Plague of Athens," and subsequently bishop of Rochester—the duke produced a mosaic of parodies of special portions of the plays of Davenant, Dryden, the Howards, the Killigrews, Sir R. Stapylton, author of "The Slighted Maid" (1563), Sir William Berkley, author of "The Lost Lady" (1639), Mrs. Behn, Sir R. Fanshawe, T. Porter, author of "The Villain" (1663), Francis Quarles, and others. Having taught the mode of mimicking Dryden to John Lacy, Villiers gave him the part of Bayes to play. Lacy was both player and playwright. He wrote "The Dumb Lady, or the Farrier made a Physician" (1672), derived from Molière's "Médecin malgré Lui;" "The Old Troop, or Monsieur Ragout" (1672); a posthumous play, "Sir Hercules Buffoon," and a condensation and vulgarization of "The Taming of the Shrew," entitled "Sawney the Scot." Dryden retaliated by issuing "Absalom and Ahithophel," in which the Duke of Buckingham appears as Zimri:

> "A man so various that he seemed to be
> Not one but all mankind's epitome,
> Stiff in opinion, always in the wrong,
> Was everything by turns and nothing long."

The town was, of course, highly amused at the burlesque and its sequel; but no good result followed from either—both went on in their former course. The duke died 16th April, 1688.

Another great dramatic burlesque is Fielding's "Tragedy of Tragedies" (Tom Thumb the Great, 1751). It is replete with the most pointed parody ever written, and the mock annotations, with which it is abundantly furnished, intensify the humour of the blank verse in which he relates the love of the hero Thumb for Huncamunca, their quarrel, Lord Grizzle and Glumdulca's fall, the terrible catastrophe of the devouring of Thumb by the expanded jaws of a red cow, and the killing all round which closes the scene more bloodily than Dryden's "Cleomenes" (The Spartan Hero). Fielding placed on the stage upwards of twenty dramatic pieces, but of these, "Love in Several Masks," "The Modern Husband," "The Temple Beau," and "The Wedding Day," with some of his translations from Molière, are nearly all that can bear reading.

Nicholas Rowe (1673-1718), the first biographer and editor of "Shakespeare" (1709), composed one comedy, "The Biter" (1716), translated Lucan's "Pharsalia" (1718), and wrote seven tragedies. Of these, "Jane Shore" (1714) and "The Fair Penitent"—the fable of which is derived from Massinger's "Fatal Dowry"—still keep the stage. They are marked by smoothness of rhythm, elegance of language, and elevation of sentiment. Susannah Centlivre, who rivalled the dramatic glory, though not the gallantries, of Mrs. Behn, wrote two tragedies, fifteen comedies, and a farce. In "The Busybody" (1709) she used "Sir Martin Mar-all" and a novel of the Duchess of Newcastle's for the plot. "The Wonder: A Woman Keeps a Secret" (1714), she borrowed from "Elvira, or the Worst not always True" (1667), by George Digby, earl of Bristol. Of "A Bold Stroke for a Wife" (1718), she asserted that the plot was new and contained "not one single tittle from Molière." These, much retrenched, hold their place in the theatre still. So does Henry Brooks' "Gustavus Vasa" (1739), and the "Barbarossa" (1754) of John Brown, D.D., of Newcastle, at whose preaching the gaming tables at Bath were suppressed by the magistracy (1750). Its author committed suicide in 1766. The Rev. James Townley's "High Life below Stairs" (1759), "The Midas" of Kane O'Hara (1764), and the "Percy" (1777) of Hannah More deserve note as readable and actable. "The Runaway" (1776), "The Belle's Stratagem" (1780), "A Bold Stroke for a Husband," and "Who's the Dupe?" (1779), are due to the cleverly inventive pen of Mrs. Hannah Cowley, authoress of the poems "The Maid of Arragon," "The Scottish Village," and "The Siege of Acre." The dramatic pieces of Isaac Bickerstaff—*e.g.* "Love in a Village" (1762), "Lionel and Clarissa," "The Padlock," and "The Hypocrite" (1768)—display versatility and talent.

HISTORY.—CHAPTER XVIII.

MODERN PROGRESS OF CONSTITUTIONAL GOVERNMENT—TERRITORIAL CHANGES AND POLITICAL REVOLUTIONS—COLONIZATION AND CIVILIZATION (1815–51).

NATIONALISM, not *Napoleonism*, is the watchword of recent history. The rule of the people by laws made with their consent, and for the general good, is now aimed at instead of the government of one or many, whose legislation is autocratic or oligarchic. This modern mode of monarchy originates in an ideal of individual liberty conserved by the will, power, and intelligence of the whole of the members of a state duly represented and determined in legal form. The supreme sovereign of society is law, and this law is represented by the monarch, president, or other real or formal repository of the nation's power over its members and of its influence among other states. In such a society the rights and duties of citizens are reciprocal, and both are constitutionally fixed by the justly balanced and combined wisdom and wishes of all. Constitutional politics is the problem of modern civilization.

By the fifth formal treaty of Vienna, signed 9th June, 1815, along with its supplementary ratification of the recommendations of the commissioners of the four Great Powers of Europe regarding rectifications of territory, mutual indemnities, rights of navigation, and other details, entered into at Frankfurt on 20th July, 1819, it was intended to settle finally the territorial boundaries of states. The great revolutionary changes which recent wars had impressed on the map of Europe could not be wholly effaced, but they might be readjusted. The bankruptcy of the Napoleonic Empire re-excited the territorial ideal, and all the powers strove to consolidate and increase their possessions. The partition of Europe was diplomatic, not democratic; the interests mainly kept in view were dynastic, not popular. Europe was divided among thirty sovereigns as proprietors, and nearly 400 inferior rulers were for *their* aggrandizement swept from their place of power. In this great treaty, the principle of the divine right of kings was set at nought—kings themselves being its contemners. The question arose—Why, if sovereign rights are divine, may they be disregarded by kings, and yet must be regarded by the people? The latter discarded the doctrine as self-belied, and—as happens so often, if not always, in statecraft as in common cunning—

> "Thus equal-handed justice
> Commends th' ingredients of our poisoned chalice
> To our own lips."

The people had fought and bled; they had endured hardness, because all the princes had promised to guarantee constitutional rights and give national freedom. These did not keep faith with their subjects, for their armed hosts upheld their thrones. The wars in which they had been engaged showed the people that theirs was the might of multitude. No nation was then minded to resume the down-trodden condition in which it had been held. Manliness began to mingle with the mass of every class. The leaven of social change had worked, though as yet it made little show.

Externally, Russia had extended her boundaries on every side. It had absorbed the greater part of Old Poland and other lands adjoining it, though it was to be held as a constitutional dependency; it occupied Bessarabia, it inclosed Prussia and Austria in its constricting folds, and it was free to insert the steel wedges of its armed hordes among the Khanates of Asia. France, compelled to surrender the territories seized by the republic and the empire, was reduced to nearly its former dimensions, and subjected—at the bayonet's point—to the dynasty she disliked. Germany ceased to be an empire, and became a laxly-leagued confederation of many small states, with the great rival kingdoms of Prussia and Austria as centres for intrigue and disaffection. But now the ideal of German unity had become the theme of poets and philosophers and the aspiration of the Teutonic peoples, and hope of its realization had been given in the proclamation of Kalisch. Similarly Italy, which from the days of Dante had longed for nationality, was parcelled out among a number of absolute princes, while large territories were held and immense influence exercised by Austria and the Pontificate. The Italian commonwealths were not, however, re-established, though San Marino retained its former freedom. Spain remained much as it had been in territory, but absolutism was made stronger. Portugal received its emigrant king from Brazil when peace came. Switzerland was compacted into a neutral confederation of twenty-two cantons, but part of Savoy was restored to the King of Sardinia. Denmark was incorporated with the German Confederation. The Scandinavian Peninsula, without Finland, which had been conquered by, and was given to, Russia, was formed into the two independent, yet confederated, constitutional kingdoms of Sweden and Norway. Britain—whose warlike prowess had won the decisive victories which made the congress possible, and had in the conflict laden herself with a debt exceeding £800,000,000—had her European possessions increased by the Island of Malta, and undertook the protectorate of the Ionian Isles; but had considerable extensions of her colonial dominions recognized—*e.g.* Ceylon, the Mauritius, some of the West India Islands, the Cape of Good Hope, and a few small stations in South America. The Turkish Empire, already weakened by the encroachments of Russia, had been despoiled of the Crimea, and Egypt had been, under its pashas, though still nominally subject to the Porte, made really independent. Greece was retained under Turkish rule, discontented though she was known to be. Servia was made a semi-dependent princedom, under a leader who had fought for its freedom from Turkish tyranny. The small clans and families of the mountainland of Montenegro (Czernagora or Karadagh), with a leaning to Russia rather than the abhorred Moslems, safe in their fastnesses, heeded no treaty. The Suliotes in Epirus, Christian fugitives as they were from the oppressions of the Sultan, were unwilling to restrain their ardour for freedom, and especially their resistance to Ali Pasha of Janina. Under Mahmoud II. there were placed tribes and races full of the smouldering fires of insurrection. The forces of the signatories of the treaty were, however, thought to be quite adequate to the maintaining of the territorial settlements thereby made and the consolidations secured by it. But Europe had become acquainted with the futility of treaty-agreements and the facility with which they could be broken or neglected when other interests seemed paramount. It had seen old institutions swept away and changed, and it knew that old ideas had been erased from men's minds. The inward forces of national aspiration had developed, and were unable to be repressed by the outward forces of centralized dynastic conventionalities. The rulers failed to reckon with the people, and confiding in repression rather than reason, the Viennese Congress resolved on a reign of power without securing, in harmony with their solemn promises and their peoples' hopes, the power to reign—sympathy, affection, and loyal trust between crown and country, ministry and multitude.

In the same year that the volcanic eruption of the French Revolution convulsed Europe, surprised statecraft, and disintegrated the established order of things, America began its constitutional life in the United States with calmness and confidence. It flourished and attained influence. While revolution seethed in Europe, evolution proceeded in the United States. Instead of the civilization of Europe recognizing the importance to social life and personal development of a large variety of types of individual character, such as can only be developed by giving full freedom to men to unfold their faculties in harmony with nature, controlled only by the interests of society, it was made to rest on an impressed uniformity of character produced by institutions organized not by, but for, the members of the body politic. All modern culture, education, and growth proceed on the principle of the best results being attained when laws for the nation are made by the nation, and the right and duty of self-development are recognized and acted on. The main conditions of social happiness are community of sympathies, interests, and associations. To these there may be added identity of race, descent, language, religion, and antecedents, because all these are large factors in creating similarity of sentiment; and geographical continuity or contiguity may also be, if not actually essential, yet highly advisable. These are all helpful in the formation of those opinions which issue

in political aims and determinations. Had the lessons of the Revolution been learned by the Congress at Vienna, the groundwork of its cessions and concessions would not have been dynastic and geographical, but national and federal. The plan they pursued was disastrous. Italy was almost immediately convulsed by chronic insurrections; Austria, in the interests of despotism, crushed the efforts of Naples and the Sicilies in 1820, and forced the Carbonari to become secret plotters. In Sardinia the same power interfered in opposition to constitutional government. The Church's dominions were singularly troubled. Only in Tuscany, through the Grand-duke Leopold's wise administration, was there peace for any length of time. Spain was the scene of revolution and counter-revolution, and in Spanish America the intolerable arbitrariness of the government resulted in the successful revolts of Buenos Ayres in 1816, of Chili in 1818, of Peru and Guatemala in 1821, and of Mexico in 1825. Portugal, like Spain, demanded a constitution, and John VI. granted it; but the "Apostolicals" urged despotism as the best rule, and only after a war was constitutionalism re-established under Pedro V. Brazil was recognized as independent in 1822. The Poles, restless and insubordinate, revolted against Russian rule. Defeat after defeat dispirited them, and Poland, even as a nominal nationality, disappeared into the Empire of Russia in 1831—Cracow going to Austria in 1846. Greece, with its glowing dreams of freedom, rose, declared itself independent, and was ruthlessly repressed. The massacres of Constantinople and Scio thrilled Europe with horror. Russia, France, and England intervened. The sea-fight of Navarino occurred 20th October, 1827, and under the presidency of the able Corfiote Capo d'Istrias a Greek state was recognized. This, after the Asiatic reverses of Turkey, ending in the military and political capitulation of Adrianople in 1829, was emancipated from the Moslems. When D'Istrias was assassinated (1831) Greece was made a kingdom (1833), but it has not even yet realized to the full Hellenic aspirations.

In France ultra-royalism, rejoicing in its triumph, encouraged despotic laws and Protestant persecutions. The revolutionary spirit was re-evoked. The Duc de Berri was assassinated in 1820, Louis XVIII. died in 1823, and Charles X., acting as an arbitrary monarch, in the three days of July, 1830, lost a throne, while Louis Philippe gained one as the sovereign of *égalité*. Belgium followed the example of France, claimed independence, and under Leopold (July, 1831) received a constitution and a king.

Alexander, emperor of Russia, having acquired preponderating power in continental Europe, with wise statecraft, while eagerly on the outlook for the imminence of war, cultivated the arts of peace at home, and yet—never missing an opportunity of harassing his neighbours—vastly increased his influence by his astute policy in every European congress and council. On his death, in 1825, Nicholas succeeded as Czar. Insurrection greeted his accession. With characteristic courage and sternness, the conspirators were put down by fire and sword, scaffold and exile. He was really "Autocrat of all the Russias." Seeing that Asia Minor afforded Turkey materials and men, Nicholas studded the Black Sea with forts, cut roads through the Caucasus, placed a navy in the Caspian Sea, and sought to secure and consolidate a basis for military operations, when the chance came, against Turkey and Persia in the East, at the same time that he kept active agencies in operation in the Moldo-Wallachian principalities, on the main stream of the Danube, and even within the fortresses of Bulgaria on the west. Paskiewitsch, by the storming of Kars, gained for him the key of Asiatic Turkey, and by the occupation of Bayazid cut Turkey off from commercial communication with Persia (1828), while the fall of Erzeroum gave him possession of the arsenal of Asia. Here the treaty of Adrianople (1829) closed this chapter of strategetic warfare in the East, not to be resumed till 1853.

The seventy-five states of which Prussia was composed gave excellent opportunity for a diplomatic game of chess. By creating and preserving a centralized military, civil, and diplomatic service, and by interweaving the interests of the largest possible number of influential minds and men in the working of these services, Prussia proposed to secure permanency and power. Almost land-locked as she was, her external position required to be encircled by defences, and to have a perpetual camp as one means of safety. Holding rule over discordant elements, Prussia had, in order to maintain peace and order, to keep its military and administrative machinery always alertly engaged. Scharnhorst, in his zeal for the overthrow of the Napoleonic Empire, had introduced the system of making every man liable to military service. This military mode, and the power, patronage, and pay it yielded, afforded a grand central influence which Prussia used to the utmost. It was put forward as the safeguard of true nationality and of intellectual freedom. But this profession of liberalism and enlightenment was accompanied by severe repression. Censorship of the press, the pulpit, and the professoriate was instituted. Great endeavours were made to keep down the German spirit in the *Burschenschaft*, in whom dwelt the enthusiasm for freedom and the thirst for political rights which had stirred the zeal of those who saved Germany in the War of Independence; and only on the side of trade and manufactures were energy and enterprise encouraged. "Wilhelm Tell" was proscribed upon the German stage.

In Austria Prince Metternich had an almost equally heterogeneous mass of subjects to control. He used an iron hand to crush any political discontent. He felt that if aspirations after German unity were fostered, Italy would also soon demand that national reconstruction which poets had sang of, philosophers commended, and politicians anticipated. By Metternich's management the Congress of Troppau (1820) was convened to take measures against revolutionary stir, and Russia, Austria, and Prussia entered into a "Holy Alliance" for the upholding of Legitimacy. Repression was maintained with greater or less success, so that it can scarcely be said that any important political events occurred in Germany till the explosion of 1848 scattered crowns and sceptres, and Metternich fled, exclaiming, in the callous phrase of Madame Pompadour, "Après moi le déluge!"

Britain, having in a great measure released herself from the territorial complications of Europe, found the transition from war to peace most trying. The wealth of the nation was heavily mortgaged, the taxation levied was enormous, great distress prevailed, trade was dull, agriculture depressed, and serious riots occurred. Christian slavery was abolished by Lord Exmouth's victory at Algiers, 27th August, 1816; Corn duties were imposed for behoof of the farming interest; and great efforts were made, by social and financial change, to bring up the leeway of legislation. Important inventions and discoveries, leading to remarkable improvements, and involving great changes in the industries of the country—the steam-engine of Watt, the spinning-jenny and the mule of Arkwright and of Crompton, the power-loom of Dr. Cartwright, and a multitude of other minor contrivances for superseding manual labour by means of machines—had enabled manufacturers to push production immensely. For example, the amount of raw cotton manufactured in England in 1785 was 17,992,882 lbs., in 1810 it was 123,701,826 lbs., in 1815 it fell to 92,525,951 lbs., but in 1825 it had risen to 202,546,869 lbs. Silk, flax, and wool had all been largely brought under mechanical power. The war had hitherto made large claims upon the men of the labouring classes, and on the working of these new machines many women and children were employed. When the war ended, a large number of industries had been revolutionized, and the labour market was almost entirely changed. These changes had also wrought great disturbances in the distribution of the population, and alterations in the moral and social conditions of those engaged in manufacturing pursuits. Britain's monopoly of the supply of merchandise to foreign nations, secured by her dominion of the seas, collapsed when other nations could resume the enterprises of peace. Banks failed, wages fell, and merchants and traders of all descriptions succumbed to bankruptcy. But the elastic energies of the nation bore up against all difficulties and vanquished them—though the massacre of "Peterloo" and the Cato Street conspiracy indicated the almost insane restlessness of the country.

Britain, accepting its insular individuality, now resolved to extend its interests and power by colonization and upon the sea. George III. died 28th July, 1820; Napoleon on 5th May, 1821; George IV. was crowned 19th July, 1821; Castlereagh ended his own existence 12th August, 1822; and George Canning succeeded him as foreign secretary.

It had been difficult during the sixty years' reign of the true-born English king, George III.—whose firmness of purpose and conscientiousness were so intense as to work him even to insanity through the difficulty arising from popular movements—to secure several reforms which seemed pressing. The independent Parliament which had been granted to Ireland in 1783 had not been found to work well, and a legislative union of Great Britain and Ireland was consummated in 1801. The parliamentary reform which Pitt proposed had not been granted, and though some concessions had been made to Roman Catholics in regard to holding office, they were debarred from a place in Parliament. Under George IV., by the Catholic Emancipation Act, this and many other restrictions were removed (1829), yet an agitation for the repeal of the union was carried on by Daniel O'Connell till his death, 15th May, 1847. The obsolete and offensive Test and Corporation Acts were repealed in 1828, then political unions were formed for the advocacy of parliamentary reform, and social disorganization became threatening. On 26th June, 1830, George IV. died, and William IV. succeeded. After much agitation Reform Bills were passed in 1832, conferring a considerable extension of power upon the people. Next year slavery was abolished in all the colonies of Britain, and £20,000,000 were granted in compensation to the owners of slaves. Numerous internal reforms and improvements were legalized and in progress when William IV. died, 20th June, 1837. Queen Victoria then ascended the throne amidst the joy of a delighted people.

There had been for many years in England a sense of fear lest Russia, pent up as she was in Europe from any available seaboard, should seek an extension of territory, and perhaps access to the open ocean, on the shores of Asia. Britain, with its sovereignty of the sea, had an indefinite opportunity of expansion, but Russia, vast as its territorial extent is, had no mode of increase except by the occupancy of such tracts of Asiatic land as lay between its possessions and those of England. England was too well guarded by intervening states to be met face to face in Europe; in Asia the terrible duel of diplomacy and warfare could find a field sufficiently vast for contest. The immense strides made by the Czar seemed to indicate that his covert intent was to combine the native princes, under his direction or dictation, in a movement to drive Britain from India.

In the year of Queen Victoria's accession, an assault on Herat was undertaken by the Shah of Persia, at the instigation of Russia and in opposition to the remonstrances of Lord Durham, as a step towards the conquest of Afghanistan. Great Britain was, by treaty, prevented from intervening between the Afghans and the Persians, and therefore Lord Auckland required to consider what other means of countercheck were available. The great powers on the Indian frontier were (1) Runjit Singh and the Sikhs, (2) the Duranis and Barukzyes of Afghanistan, (3) the Shah of Persia, and (4) the Ameer of Scinde. The Simla proclamation (1838) explained Lord Auckland's plan of replacing Shah Soojah on the throne of Afghanistan. The British army marched to the Punjab. The Indus was crossed, the Bolan Pass traversed, Candahar, Ghazni, and Cabul stormed, and Shah Soojah crowned. Subsequently revolts arose. Herat declared against the British. A conspiracy was organized at Cabul, Burnes was murdered, and in 1841 the abandonment of Afghanistan was agreed to—the Afghans covenanting, by protection, provisions, and money, to secure the safe retreat of the British forces. Macnaughten was murdered by Akbar Khan, by whose orders also the massacre of the troops occurred (in 1842)—Dr. Brydon alone being left to tell the tale. Lord Elphinstone was sent out to pursue a policy of peace, the Afghan War was closed with the destruction of the fortress of Cabul by "the army of retribution;" but Scinde and Gwalior having shown signs of disaffection, were punished in 1843 by Sir Charles Napier at Meanee and Hyderabad, and by Lord Gough at Maharajpore. The Sikhs next planned a concentrated attack on the British territories in India, and Sir Henry Hardinge, who had superseded Lord Ellenborough, concentrated 50,000 men on the east bank of the Sutlej. The first Sikh War was made memorable by the battles of Moodkee and Firozeshah (18th and 23rd December, 1845), Aliwal and Sobraon (28th January and 18th February, 1846), and ended in the occupation of the Punjab, the recognition of Dhulip Singh, and the establishment of the Rajput Gholab Singh as governor of Cashmere. The Sikhs, though they remained quite for a while, were not yet sufficiently impressed with a sense of British power, and under Lord Dalhousie the second Sikh War broke out. The Punjab was in revolt. Herbert Edwardes defeated Moolraj at Sudasain, 1st July, and the indecisive battle of Ramnuggur was fought under Lord Gough, 22nd November, 1848. On 14th January, 1849, a sanguinary battle took place at Chillianwalla, on 22nd Mooltan was captured and garrisoned by the British, and on 20th February the victory at Gujerat made the annexation of the Punjab possible. In the same year the Raj of Satara was declared to be at an end, and was absorbed into the Presidency of Bombay. During Lord Dalhousie's tenure of the viceroyalty, the second Burmese War was closed in the same year by the annexation of Pegu; Berar, on the death of the Rajah of Napore, and the Carnatic, when Azim Jah became nominally Nabob, were annexed in 1853; and the Raj of Jhansi, in Bundelcund, was brought entirely under British rule. So far, the designs of Russia upon India had led to most untoward results, and had excited much uneasiness in those political circles where diplomacy and political tendencies are most keenly canvassed.

In the speech, delivered 20th November, 1837, to her first Parliament, Queen Victoria recommended the state of the province of Lower Canada "to serious consideration." In 1790, after the American War, Britain had rewarded the loyalty of Canada by granting it a Constitution and a Representative Assembly. This recognized two provinces—east, where most of the people were descendants of old French settlers; and west, where American royalists and British colonists predominated. During the war of 1812–14, though the colony remained faithful to Britain, ill-feeling had arisen between the provinces. Western or Upper Canada, like the mother-country, was split by party; Eastern or Lower Canada, not being so divided, was able to vote straight, and it had, too, from its position considerable control over the exports and imports. Feeling their power, the Lower Canadians demanded an elective legislative council and control over the executive. This Britain refused to concede, and Lower Canada rebelled. They were, at St. Eustace, put down, and at Toronto repulsed. Earl Durham was appointed High Commissioner to meet the emergency and provide for the future government of the colony. He suggested a federal union of the whole of the British North American colonies. His proposal was rejected, he resigned, and died in 1840. The two provinces were united, and the far-seeing policy of Lord Durham has since, as far as possible, been adopted—to the immense advantage of the prosperity and population of the British possessions in the north of the New World.

Mehemet Ali, pasha of Egypt, in the course of his efforts to throw off the supremacy of Turkey in 1839, having secretly secured the support of France, invaded Syria. This the European powers resisted as tending to reopen questions of territorial redistribution. A treaty was prepared by Lord Palmerston, and agreed to by all the powers except France. Britain promptly intimated that unless France concurred by a specified day, the document would be signed and acted on without her. She made no sign, and in 1843 Sir Charles Napier—the conqueror of Don Miguel's fleet (5th July, 1833)—defeated the Egyptians at Kelbzer, drove Ibrahim Pasha from Beyrout, and stormed Sidon; while Admiral Stopford—after four hours' bombardment—took St. Jean d'Acre, the fortress which had resisted successfully the endeavours of Napoleon. Not until twenty years after that did France intermeddle. In 1860, during the feuds between the Christians and Mohammedans, and after the massacre at Damascus, she landed 4000 soldiers at Beyrout. Under convention with Britain, France evacuated Syria, June, 1861.

In the south, no less than in the east and west, were the anxieties of a world-empire impressed on the government. Cape Colony, in South Africa, which had been confirmed as a British possession in 1814, was, after the peace, colonized by discharged soldiers and sailors, to whom grants were assigned, and after the Kafir War under their prophet Makanna was closed, in 1819, people of almost every occupation found their way to Algoa Bay, Graham's Town, and Port Elizabeth. In 1828, after the Kafirs had been driven from the Kat River Valley, Dutch was discontinued and English made the official language of the colony. Under the European settlers the Boers were moved forward towards the Kafir frontiers, and in the struggle (1836–38) which next ensued the Kafirs were driven over the Great Kei. Thereafter Sir B. Durban fringed the settlement with Fingoes—a deteriorated race of Kafirs who form a separated class. Britain, feeling the difficulty of dealing with its criminal population, was induced by some influence to try, by removing thither from the Bermudas some of those who were sentenced to long periods of transportation, if a barrier could not be raised between the Kafirs and the colonists. The latter rose indignantly at the proposal. There had been a severe action between the queen's troops under Sir Harry Smith (the hero of Aliwal), then governor of the Cape, and the Dutch Boers, led by Prætorius, at Bloem Platts, in 1848, and considerable discontent was felt. Anti-convict associations were formed, the governor suspended the order, and the agitation resulted in the granting of a constitution to Cape Colony, 1853. Natal, to which many of the Boers emigrated in 1837, was in 1843 proclaimed a British possession, and in 1856 was erected into a distinct and separate colony.

New South Wales was suggested by Captain Cook as a suitable place for deporting convicts, when the Carolinas were, by the results of the American War, no longer available. The first shipload landed in 1788. Sheep were introduced in 1797. General Macquarie, governor (1810–20), was said to have found it "a garrison and a gaol," and to have left in it "the broad and deep foundations of an empire." In 1840 the colony resisted the deportation of convicts; in 1851 gold was discovered; and in 1855 New South Wales received a representative government. South Australia was colonized in 1836 on Wakefield's plan of purchase, not squatting, and in 1855 was endowed with a popularly elected legislature. On 1st July, 1851, gold was found in Victoria on the same day as it received its title and the right of Home Government. West Australia became an independent settlement in 1829, and twenty years later asked convict labour, and was twitted with being "a great English prison." Queensland was a convict settlement in 1824, and until 1842 no encouragement was given to free settlers, but in 1859 it acquired a constitutional existence. Tasmania had obtained a similar recognition three years earlier. Colonization began in New Zealand in 1840. A treaty with the native Maoris was made, but misunderstandings arose, and the first Maori War (1845–48) occurred. Under General Grey a legislative council was granted in 1840, and improved in 1856.

In 1839 China, having refused to sanction the smuggling of opium into its territories, had a war forced upon it which resulted in the seizure of Hong-Kong, January, 1841, and its ultimate cession to Britain by the treaty of Nankin in 1842. It is governed as a crown colony. In these and in other ways, within a period which may well be called recent, history has seen the growth and spread of British colonization and civilization, until it has become so vast that the colonies and dependencies of Great Britain comprise one-sixth of the land on the face of the globe, and hold within them nearly as great a proportion of its population. Its flag waves supremely in each sea, and the sceptre of its sovereign extends its sway over an empire on which the sun never sets. All these she is preparing for a self-regulating political existence, and training them to make

"The bounds of freedom broader yet."

Queen Victoria being excluded by the Salic law from succession to the kingdom of Hanover, Britain was relieved from possible complications in continental affairs. Thus she was at liberty, without other than diplomatic interference, to proceed in that course of gradual development of national and social life which aimed at bringing theoretical politics cautiously, and under well-considered safeguards, into fuller influence on practical and administrative government. The very different condition of things which had arisen in the recent transition of Britain from a community of agriculturists and artisans to one of steam-driven industries and immense mercantile interests, and from a power involved in continental politics to one intrusted with the management of the mightiest and most diversified colonial acquisitions, had necessarily originated governmental difficulties and started questions to which no direct precedents could apply. By the new Poor Law and the Municipal Reform Act endeavours were made to introduce a machinery of a self-adjusting sort. Differing opinions, varying interests, mismatched measures, laws referring to obsolete circumstances used in dealing with unforeseen emergencies, created a desire for the quickening of the power whose duty it was to bring things into a fairly settled state. Hence arose (1) Chartism, 1838, claiming that as taxation and obedience were universal, representation as a means of self-protection against inequality in the incidence of the one and injustice in the enforcement of the other, should be made as wide and all-prevailing; (2) socialism, seeking the reorganization of society upon a new moral system (founding on Owen's "Essays on the Formation of Character," 1816); (3) the Anti-Corn-Law agitation for the cheapening of bread to the poor, and the general amelioration of the condition of the people, which, by the bad harvests of previous years, had become grave and serious (1839), though success did not crown its efforts till famine, arising from failure of the potato crop in Ireland, threatened starvation in 1846; (4) strifes between capital and labour, manifesting itself in stubborn strikes; (5) endeavours by sanitary laws, factory acts, organized charities, home missions, and other philanthropic schemes, and (6) the levying of an income tax to enable the necessaries of life to be cheapened by the reduction or removal of fiscal burdens.

Then came the year of revolutions (1848). Switzerland had—since the action taken by the Ultramontanists in regard to Dr. Strauss in 1839—been agitated by the contests of the Free Corps, and the Sonderbund. The Catholic League was put down at Freiburg and Lucerne, and the Jesuits expelled (1847). By diplomatic notes it was attempted to intimidate the Swiss; but the Radicals revised their constitution, and made their central government a stronger corporation (1848). Neuchatel declared itself independent of the King of Prussia, and assumed a Swiss-like constitution, 29th February, 1848. In November, 1847, the King of Sardinia signed an organic law establishing municipal institutions and provincial councils. He subsequently granted a constitution, and adopted the cause of Italian unity against Austria. Sicily revolted against the King of Naples, and the constitution of 1812 was restored. In Tuscany representative government was claimed and granted. In France Guizot was impeached, Louis Philippe abdicated, and a provisional government was established, which proclaimed a Democratic Republic as that best suited to the genius of the French. The Italian flag was hoisted in all the cities of North Italy in revolt against Austria. She granted a Legislative Senate and Chamber, allowing one representative for 30,000 subjects, and was compelled to accept a democratic ministry. The King of Bavaria was compelled to abdicate, and ultimately fled. When fighting began in Berlin the King of Prussia promised to undertake the reconsolidation of the German Empire, but afterwards resiled, and a civil war resulted, though he granted a new constitution in December. The Austrian Emperor's abdication was signed 2nd December. The Hungarians also rejected his rule, and Kossuth took with him to Debreczin the iron crown of St. Stephen, but in March, 1849, the new emperor, Francis Joseph, issued a fresh constitutional charter for the entire empire.

In May, 1849, Prussia having three weeks previously been placed under martial law, the Emperors of Austria and Russia held an interview regarding the state of Europe. A Russian army co-operated with Austria in crushing the

revolutionists, and the Porte protested against Russian troops forcing a march through Turkish Transylvania in July, 1849. Shortly afterwards, by the help of France, the Pope was restored to temporal power in Rome. The King of Prussia and the Austrian Emperor met at Toplitz, and consulted with the sovereign of Saxony in September, 1849, while a universal Peace Congress was sitting at Paris. Russia and Austria made a joint demand on Turkey for the surrender of Polish and Hungarian rebels and refugees. This the Porte refused. Through Kossuth the refugees claimed the protection of Britain, and a fleet was sent to the Dardanelles. Russia, towards the close of 1849, resumed diplomatic relations with the Porte, and the refugees were transferred to Konieh in Asia Minor; the ex-governor of Hungary was, through the influence of England and the United States, liberated in September, 1851, and was treated by Austria as an *extradit*. In the long run the German Diet was reconstituted, and after a conference on the condition of affairs, held at Warsaw, between the Emperors of Russia and Austria, and with a number of distinguished diplomatists, North and South Germany were aggregated round Prussia and Austria again, and very soon the constitutions granted were subjected to a good deal of minimizing manipulation. Hungary was again attached to Austria, Poland was thoroughly reduced to Russian serfage, and the magnitude of the military power of that great empire was demonstrated by a conscription, amounting to 7 per 1000 of its population, to swell its armies. As the political relations of the sovereign powers speedily resumed their old lines the turmoil ceased, and the revolutions of 1848 showed few results in 1850 as compared with the hopes entertained, the aims proposed, and the excitement which was produced.

Meanwhile the insularity of Britain enabled it to keep clear of the continental complications of crowned-heads and rebel citizens, though she was not by any means free from special difficulties of her own. The echo of revolution reverberated through the three kingdoms. Daniel O'Connell, the most powerful agitator for repeal, had died at Genoa, 15th May, 1847; but W. Smith O'Brien and Francis Meagher, repudiating his abstention from insurrectionary war for the attainment of "their country's rights," led the Young Ireland party to adopt an address to the French Republic, and were received as a deputation by Lamartine. They organized clubs, recommended the arming of the people, and a rising having taken place near Ballingarry, the leaders were seized, tried, convicted, and at length, after protracted legal proceedings, transported in 1849. The rebellion meanwhile collapsed. The Chartists, excited by the continental news, craved hearing for their cause and redress of popular wrongs. They proposed to march in procession to the House of Commons with a monster petition, but Government gave them to understand that no such form of intimidating Parliament would be permitted. Shortly afterwards the Chartist Convention was dissolved, and a new plan of peaceable agitation throughout Great Britain and Ireland was proposed by the Reform League. Next year Mr. Cobden issued suggestions for the securing of a more economical and equitable system of taxation, and Mr. Bright proposed the extension of the franchise through the freehold lands qualification. As a counteractive against these liberal proposals, a Conservative Association for the Protection of British Industry and Capital was inaugurated. Both parties did good service by educating the masses to the consideration of the principles of politics and their practical results. On the thousandth anniversary of the birth of Alfred the Great (849) the government and people of England were beginning to realize the ideal he had briefly sketched, thus:—"These are a king's materials and his tools to reign with: that he have his land well-peopled he must have headmen, and soldiers, and workmen. Thou knowest that without these tools no king can show his craft. This is also his material: that he must have, beside the tools, provision for the three classes. This is then their provision—land to dwell in, honours and weapons, meat and ale and clothes, and whatsoever is necessary for the three classes. He cannot without these preserve the tools, nor without the tools accomplish any of those things which he is ordained to perform."

The Prince Consort, Albert Edward of Saxe-Coburg and Gotha, whom Queen Victoria had chosen, and to whom she was wedded 10th February, 1840, seemed to have been wholly imbued with the spirit of Alfred's lofty aspiration: "I wished to live honourably while I lived, and after my life to leave to the men who come after me my memory in good works." Choosing for himself the culture of the arts of peace and the promotion of social progress, he laboured earnestly for the well-being of the nation generally, but especially for the amelioration of the condition of the poorer classes. In all (non-political) philanthropic movements he was active. He encouraged the erection of model lodging-houses, public baths, industrial schools, and institutions for the furtherance of popular instruction in science, arts, and industry. Social, scientific, and artistic matters did not wholly engross him. Though he knew well the reserve which he required to exercise in regard to party politics, his wide knowledge, profound wisdom, and cautious prudence made his counsel often valuable to the nation, while his lofty sense of personal and political honour won the respect of the statesmen of the day. Noting that now the disturbances of Europe were quieting down, trade and commerce reviving, contentment gaining ground, and confidence increasing—in the belief that it would be advantageous for all interests to awaken in men's minds a deep sense of the value of peace and of the blessings likely to accrue from the universal recognition of the true fraternity of nations—he proposed that, as a step towards and a foreshadowing of the realization of the sympathetic unity of mankind, an exhibition of science, industry, and art should be held in England to inaugurate the second half of the nineteenth century with some distinct sign of the prevalence among men of the value of peace, love, and ready helpfulness not only among individuals, but among the nations of the earth. The idea caught the spirit of the age. It was realized when, on 1st May, 1851, Her Majesty, in the presence of 25,000 spectators, opened the renowned Crystal Palace Exhibition, welcomed under its dome the representatives of the world, and spoke words of peace and good-will to all who had been concerned in making possible this visible encyclopedia of the products of nature, the marvels of science, the results of industry, and the triumphs of art, amidst the applause of the most magnificent assembly ever congregated in the world.

GEOGRAPHY.—CHAPTER XVII.

GREAT BRITAIN—IRELAND.

Ireland is a large island, having an area of 32,524 square miles. It lies west of Great Britain, from which it is separated by the North Channel, the Irish Sea, and St. George's Channel. The east coast of Ireland approaches within 13 miles of the Mull of Cantyre (Scotland) in the North Channel. The Irish Sea is 138 miles wide, and St. George's Channel, in its narrowest part, 47 miles wide. The Atlantic Ocean washes its north, west, and south coasts, which are deeply indented. In length, measuring diagonally from Malin Head in the north to Mizen Head in the south, Ireland extends more than 300 miles, and in breadth, from Slyne Head, Galway, to Howth Head, near Dublin, is a stretch of 174 miles.

1. Superficial Features.—The general form of Ireland is that of an oblique parallelogram. The west seaboard is lofty, precipitous, and abrupt; the south-west, exposed to the fury of the Atlantic, is broken into bluffs and cliffs, between which run inlets, harbours, and arms of the sea. The eastern coast is flat and comparatively little indented.

The surface is diversified by mountains, bogs, lakes, and plains. Although an undulating or hilly country, it is less rugged than the Highlands of Scotland, but not so flat as the east of England. The centre is occupied by a vast level, extending from the sea at Dublin to the Bay of Galway on the west, and from Sligo and Fermanagh in the north, to Cork and Waterford in the south. This plain consists of cultivable land and upwards of 1,000,000 acres of bog, broken

by undulating hill ranges. The Bog of Allen is 268 feet above the sea-level, and is the source of several rivers. Nearly one-seventh of Ireland's entire surface consists of bogs.

The chief mountain groups are in Wicklow, Tipperary, Limerick, and Kerry on the south. In the north-east a mountain range occupies the southern angle of Down. Monaghan, Cavan, and Fermanagh are somewhat mountainous; while Antrim, Londonderry, and Donegal in many parts present a rugged and sterile aspect. In the west of the province of Connaught, the mountain ranges are distributed round the coast, the rest of the land being tolerably level.

2. Climate.—Ireland is remarkable for moistness of climate, and for being less liable to severe cold than its neighbour countries. Even in the north of Donegal, the arbutus, laurustinus, and fuchsia grow luxuriantly in the open air; and myrtles reach the height of 8 or 10 feet. Little of its land is more than 50 miles distant from the sea, and its general height above the ocean-level is slight. Mild westerly and south-westerly winds blow for nearly three months in the year. The climate, although mild, is variable along the south and west. The ripening of the crops is often retarded, and the harvest obstructed, by wet setting in early in autumn. The humidity of the climate varies much in different districts of the country; in the south and south-west 42 inches is the average fall of rain, while in the north-east it is little more than half that amount. In the south, the harvest is a month earlier in general than in the extreme north, and a fortnight before the midland districts.

3. Mountains.—Except Wicklow range, with its lovely glens and valleys, the Mourne Mountains, and the long ranges of Slievenaman, Slieve Bloom, and Knockmealdown, the hills of Ireland occur in isolated groups. Of these, the following are the names, situations, and heights:—

	Height in Feet.
Carrantual, Macgillicuddy's Reeks, in Kerry, .	3404
Mount Brandon, north of Dingle Bay, . .	3120
Lugnaquilla, Wicklow Mountains, in Wicklow,	3039
Slieve Donard, Mourne Mountains, in Down, .	2796
Mangerton, Lake of Killarney, in Kerry, . .	2754
Great Nephin, in Mayo, ...	2646
Commeragh, in Waterford, ...	2469

4. Plains.—Besides the great plain in the centre of Ireland already noticed, there are several extensive ones in other parts of the island. Those in Tipperary and Limerick are extraordinarily rich and fertile. The level lands on the banks of the Shannon and Fergus afford the best pasture in the United Kingdom, and are as well adapted for grazing and agricultural purposes as any part of Europe. A vast bog extends along the banks of the Inny, skirts the Shannon for miles in its course through Longford, Roscommon, and King's County. The great Bog of Allen stretches over a large portion of country. These bogs, although wet and deep, are not without their value. They consist of peat or turf capable of use as fuel. Irish bog is said to be readily susceptible of drainage, reclamation, and profitable cultivation.

5. Rivers.—The mountains of Ireland being external to the great central plain, there is little room left between them and the sea, so that the courses of the rivers are necessarily short. These are divided into three groups—those that drain (1) the central plain, (2) the mountainous districts external to the plain, and (3) those that fall into the Shannon. The chief rivers of Ireland are:—

Name and Direction.	Counties through which they flow.	Chief Towns on their Banks.	Termination.
Shannon (S., S.W., W.),	Separates Roscommon, Galway, and Clare, from Leitrim, Longford, Westmeath, King's County, Tipperary, Limerick, and Kerry, ...	Leitrim, Carrick, Athlone, Killaloe, Limerick, ...	Atlantic, length 254 miles.
Blackwater (E.S.E),	Cork and Waterford, ...	Youghal, Mallow, and Fermoy, .	Enters the sea at Youghal Bay.
Barrow (S.), ...	Separates Queen's County and Kilkenny on the west from Kildare, Carlow, and Wexford on the east, ...	Carlow, New Ross, and Athy, .	Waterford Harbour.
Suir (S.S.E.), . . .	Tipperary, and between Kilkenny and Waterford, ...	Thurles, Clonmel, Carrick, and Waterford, ...	Waterford Harbour.
Nore (S.E.), . . .	Kilkenny, ...	Kilkenny, ...	Falls into the Barrow.
Lee (E.), ...	Cork, ...	Cork, ...	Cork Harbour.
Slaney (S.S.E.), . .	Carlow and Wexford, ...	Tullow, Enniscorthy, Wexford, .	Wexford Harbour.
Ovoca (S.E.), . . .	Wicklow, ...	Arklow, ...	St. George's Channel.
Liffey (W., N.E., E.),	Wicklow, Kildare, and Dublin County,	Dublin, ...	Dublin Harbour, after a very winding course of 50 miles.
Boyne (N.E.E.), . .	Kildare and Meath, ...	Trim, Navan, and Drogheda, . .	Irish Sea.
Bann (N), ...	Down, Armagh, and between Antrim and Londonderry, ...	Coleraine, ...	North Channel.
Foyle (N.W., N., N.E.),	Tyrone and Londonderry, . . .	Omagh, Newton-Stewart, Lifford, and Londonderry, ...	Lough Foyle.
Lagan (N.N.E.), . .	Down, and between Antrim and Down,	Belfast, ...	Belfast Lough.
Erne (N.N.W.), . . .	Longford, Cavan, and Fermanagh, .	Belturbet, Enniskillen, and Ballyshannon, ...	Passes through Lough Erne, and flows into Donegal Bay.

None of these rivers are naturally of much use in internal navigation; but the Shannon has been made navigable to Lough Allen by deepening its bed and forming locks; the Barrow, to Athy; the Foyle, by canal, to Strabane; the Suir is naturally navigable, for barges, to Clonmel; several other rivers have been artificially united by canals. The principal affluents of the Shannon are—the Boyle, the Inny, the Suck, the Brosna, and the Maigue.

6. Lakes.—These are extensive and numerous, with a surface of 455,400 acres. The principal are the following:—

Lough Neagh, surrounded by the counties of Antrim, Down, Armagh, Tyrone, and Londonderry, 18 miles long, about 11 broad; area, 154 square miles. It forms an inland navigable basin.

Lough Erne, a beautiful lake in Fermanagh, consisting of two basins, and studded with numerous islands.

Lough Derg, a small lake in Donegal, containing some islets.

Lough Conn, in Mayo, 40 feet above the level of the sea.

Lough Mask, on the borders of Galway and Mayo, 68 feet above the level of the sea. A subterranean channel connects it with Lough Corrib, in Galway, a beautiful lake about 27 miles long, and from 1 to 6 broad, studded with islands, 14 feet above sea-level.

Lough Allen, in Leitrim, the source of the Shannon.

Lough Ree, between Roscommon on the west, and Longford and Westmeath on the east. It is 14 miles long by 6 broad.

Lough Derg—23 miles long, 2 to 6 broad, 100 feet above sea-level—separates Galway and Clare from Tipperary.

Lakes of Killarney, three beautiful sheets of water in the county of Kerry, inclosed on all sides by mountains 2000 to 3000 feet high, which are clothed with the richest natural wood of every kind. The upper lake is three-quarters of a mile long; the middle lake, a mile and a half; and the lower lake, $3\frac{1}{2}$ miles long by 2 broad.

7. Bays, Gulfs, and Straits.—Many bays and gulfs (loughs) indent the island, and are of commercial importance.

(1) *On the east coast the chief are:—*

Belfast Lough, 13 miles long, 5 to $7\frac{1}{2}$ wide, affords good anchorage.

Strangford Lough, in Down, 17 miles long, 4 wide. It has a narrow dangerous entrance, but is a beautiful bay inland.

Nicolas Boileau Despréaux was born at Paris in 1636. He was a slow sickly boy, diligent, but unambitious. When twenty-one he was admitted advocate, but disinclined to that profession he went over to the church, and for a time held a sinecure benefice. Betaking himself to letters, his poetic career may be divided into three periods—(1) that of his youthful impetuosity and intensity (1660-68), in which, without mercy, he declaimed against the false taste imported from Italy and Spain and the bad poets who yielded to it. This was accomplished by his nine earlier satires. Having in these, precipitately enough, overturned and destroyed, he set himself to reconstruct (2) his artistic elaboration of language (1668-77). In the "Art Poétique" (1674) he formulates, and in "Le Lutrin" (1681), a mock-heroic poem, exemplifies the mastery of the versification he advocates, and exhibits pungent wit and trenchant satire. His nine epistles belong also to this period—that addressed to Racine being the finest product of Boileau's pen. Then his official career comes on. As historiographer to Louis XIV. his poetic labours were interrupted for nineteen years; and (3) the muse resumed her sway and she gave forth three satires and three epistles, as well as a rather modern-like made-to-order "Ode à Namur" (1693). Overcome by dropsy he died 1711.

Jean de la Fontaine was born at Chateau-Thierry in 1621. On hearing one of Malherbe's odes read, the poetry in his soul awoke. He read Rabelais, Marot, Voiture, D'Urfe, and such other old writers as he could get hold of, and his nature became so profligate that he seemed to see no heinousness in sin. His "Tales" (1665) show the vice of his heart. On the fall of his patron Fouquet, however, the poet composed one of the most plaintive and touching elegiac pieces in the French of that age, addressed "Aux Nymphes de Vaux." Fortunately La Fontaine's fame does not rest on the "Contes et Nouvelles" he composed to gratify the niece of Mazarin; his "Fables" fit all times, ages, and conditions. They amuse children, instruct men, and excite the admiration of the literary. While matchless in the perfection of their style, they are irreproachably pure in their moral tone. In them he is the simplest, the least pretentious, and the most universal in his sympathies of all the poets of the seventeenth century. He is not original in his material; for that he goes to Vishnu, Æsop, Phædrus, &c., but he sets them all to music and imparts to them charming simplicity and freshness. In 1696 La Fontaine died old and famous, but poor and repentant. He is the familiar of the fireside in France.

Honorat de Bueil (1589-1670), a disciple of Malherbe, was inferior in accuracy of diction and regularity of rhythm, but superior in gracefulness of turn and sweetness of feeling to his celebrated master. He has a Virgilian love of the country, and weaves his words into music more pleasing than any French verse prior to Racine's melodious flow of felicitous expression. J. R. de Segrais (1624-1701), besides having a share in the composition of the romances of Madame Lafayette, furnished France with a fair translation of the Æneid, and composed some beautiful idyls, in which the plain and simple story of shepherd life is finely told, pastoral scenery pleasingly described, and rustic feeling admirably stated. Madame Deshoulières (1633-94) enjoyed under Louis XIV. distinction for her idyllic poetry. J. P. C. de Florian (1755-94) ranks next to La Fontaine as a fabulist. Like him he drew his material from all sources; but he is so ingenious in phrase, so happy in arrangement, and so choice in the management of details, that he holds a high place in the esteem of the best critics.

Prose Writers.

Descartes arose in an epoch of philosophical decrepitude, when neither knowledge, wisdom, nor freedom prevailed. Into the midst of the ignorance, dogma, and intolerance of his age he strode as the bearer of a new *methode* in speculative science, the object of which was to find a basis for, and a criterion of, certainty. The phenomena of mind are experienced, are first facts, and require no other proof. *Cogito* expresses the reality of mental consciousness, *ergo sum* does not complete a syllogism, but forms a statement of a fact of personal consciousness grounded on reflective experience. These, however philosophy may sift or analyze them, cannot be doubted. Scepticism is an impossibility, for if it exists it does so as a state of mind, and must be accepted and believed in as such. Science systematizes the phenomena of consciousness, and philosophy appears—appears as antagonist alike of scepticism and dogmatism, claiming to be truth. He does not, it is true, give proper prominence to the activity of the thinking self, and regards it rather as the subject of the peculiar phenomena of thought, than as itself and in itself an originator of thought. Leibnitz reclaimed for the mind a causative force, while Spinoza, looking on mind as a mere reflective passivity, fell into fatalism. This he would not have done had he grasped Descartes' ideal of method as an organized and systematic exploration of experience—in the world *without* as keen as that of Bacon's, and in the world *within* as circumspect as Plato's—an earnest searching insight into what consciousness feels and reveals—not as Locke and Condillac treated it, as a pure white paper-like receptive form for sensations, nor as Kant and Reid regarded it, as a prepared scroll with ideas written into its inner tissues, but as a living agent self-conscious as well as world-conscious, in which ideas develop, and to which existence, eternity, infinity, and God are made reflectively manifest. In dignity of power Descartes is unquestionably the compeer of Bacon and Newton, in reach of influence he is unexcelled except by Plato and Aristotle. He was born the scion of a noble family at La Haye, in Touraine, 1596, and educated at the college of La Flèche. He entered the army, and as a soldier did military duty in Holland, Germany, and Hungary. When thirty-three he retired to Holland and devoted his life to contemplative thought. Exposed to persecution for his opinions, he accepted the invitation of Christina of Sweden to settle in Stockholm, where he died 1650.

Of Port Royal, the headquarters of Calvinistic Catholicism, it is impossible to write in less space than a volume. Of Saint-Cyran, its Director; of La Mère Angélique and her three brothers, the Arnaulds—Lancelot the grammarian, Nicole, philosopher and moralist; Le Maître the advocate, Séricourt and De Sacy his brothers, the nephews of La Mère; and Pascal, a man all soul, who from his eighteenth year endured one continued penance, mathematician at sixteen, philosopher at eighteen, and all his life the advocate of common-sense against authority. "Les Lettres Provinciales" run through the whole gamut of the powers of man "from grave to gay, from lively to severe," and his "Pensées" are precious to all thinkers and religionists. Equally impossible is it to characterize their well-matched opponents, St. François de Sales (1567-1622), bishop of Geneva, to whom nature was a symbol of God, who united the vivacity of Molière with the *ésprit* of Montaigne; and Bossuet, the glory of the Jesuits and the unequalled pulpit orator, who was adored while living and revered when dead.

A number of novels professing to relate court scandals and the loves of the monarchs of France were written, and have justly been forgotten; but Madame Lafayette marks an epoch in French fiction by those agreeable records of real events, combined with imaginary incidents, in which the human passions are exhibited acting in something like a natural way. Voltaire credits her with being the first French novelist who described the manners of respectable people, and exhibited adventures consistent with nature and good taste. This favourable turn in imaginative literature was still further aided by P. de Marivaux (1688-1763). This author had a metaphysical mind, but was somewhat monotonous in thought. His comedies are more interesting than his novels. Jean Louis Guez de Balzac (1594-1654), as a reformer of French prose, has rivalled Malherbe's influence over poetry; his enrichment and embellishment of the language are noticeable, and in his "Lettres" are to be traced the beginnings of that epistolary grace for which the French have an undoubted talent. Voiture, too, with almost fatiguing brilliancy of phrase delights and dazzles as a letter writer. Voltaire called him the first *bel-ésprit* in France. Le Sage (1668-1745), drawing from the Spaniard Guevara the plot of "La Diable des Boiteux," gave it a most tasteful French dress; and so thoroughly embued

with the Spanish spirit did he become, that the Spaniards contend that his "Gil Blas" is really a translation. It is amusing, full of good sense, and instructive. L'Abbé Prévost (1697) was, as Voltaire says, "not only an author, but a man who had experienced many passions." His "Manon Lescaut" (1734) narrates the fatal intoxication of licentious indulgence, and throws the glow of an ardent but hectic imagination over shameful love, unhallowed intrigue, and unchecked extravagance. His works extend tc 170 vols.

L. de Rouvroy, duc de Saint-Simon, one of the last of the great lords of France and one of its greatest historical writers, was born in 1675, and appeared in the court about the end of the reign of Louis XIV. His "Memoires" contain the real history of *le grand siècle.* They have all the vivacity and a good deal of the inaccuracy of expression of an improvising writer. The overflowingness of Scudéry is in him united to the conciseness of Tacitus. His eye-witness records are remarkably striking. Though their author died 1753, the first authentic edition only appeared in 1828–31. Another writer of "Memoires" also requires mention, Paul de Gondi, cardinal de Retz, born at Montmirail. He was coadjutor to his uncle, the archbishop of Paris; he put himself at the head of the Parisians in 1648, against the Regent Anne of Austria and the minister Mazarin. He was imprisoned in 1652, but managed to escape. He returned to France in 1664, renounced politics, and devoted himself to composing his "Recollections of the Times" in which he lived. In 1717 these lively models of familiar history were published. In them the man who sought to be the Catiline of the Frondeurs, appears as the Sallust of that conspiracy, and outshines his contemporaries in graphic, animated, and vivid description.

The *Cyclopædia* published by Ephraim Chambers in 1728 was translated into French by an Englishman named Mills, and was, though not published, used by Diderot and D'Alembert in the production of their famous *Encyclopédie* (1751–72, supplement, 1776–77, and analytic index, 1780). Among its contributors were Dumarsais, Grimm, D'Holbach Jaucourt, Rousseau, and Voltaire. Biography and history are excluded from its scope. The impracticable revolutionary ideas of mere theoretical politicians prevail too strongly in it, and a virulent sceptical bias against anything religious materially injures it; yet it must be admitted to be marked by depth, ability, and originality, and to have secured for its editors and contributors a name and place in literature seldom granted to those who engage in such work. It was enthusiastically received, and as the *Encyclopédistes*, its writers were undoubtedly the originators of the French Revolution. Diderot was a sort of lazy scapegrace while young, and would settle to nothing—law, church, or trade; but he read voraciously and wrote rapidly. His first original work was entitled "Pensées Philosophiques," desultory and commonplace, but marked by the new sceptical thought of the age. His style is clear, easy, pointed, and strong. His minor tales are popular, but scarcely pleasing, and of several the plot and characters are alike repulsive. The works of J. L. d'Alembert (1717–1783) comprise his celebrated preliminary discourse to the *Encyclopédie*, "L'Essai sur la Société des gens de lettres avec les grands," "Memoires et Réflexions sur Christine reine de Suède," selections from Tacitus (translated), "Eléments de Philosophie," and many dissertations. He was a leading spirit among those whose maxim was "*tout change avec temps*," whose cry was culture, and whose aim was change.

The faith of the philosophers in themselves overcame all other faith. Then Jean Jacques Rousseau projected into society his new evangel of a "Contrat Social," and furnished the ideas and the phraseology prevalent during the Revolution. It begins with the theoretical paradox, "Man is born free." He emerges from this state of nature by an act of will when he joins the society of civilized men. On this contract civilization is founded, and the state is erected by convention. The sum of the individual wills of men constitute the general will, and that is law. The people is the sovereign. *L'état c'est moi* is a mistake; *L'état c'est le peuple.* In a life of wandering and want, begun as the son of a watchmaker at Geneva in 1712, Jean Jacques developed amid misery and humiliation that genius which enabled him to take rank as a botanist, novelist, poet, publicist, and philosopher among the most eminent of French writers. His aims were to place national politics on a firm basis, to secure the express culture of each mind to its highest and best as a human duty, and to awaken in the heart the love of nature and the love of man as the practical poetry of life. His was the Napoleonism of ideas. He overturned society, and delighted it while doing so. As he says himself, "The despot is only master so long as he is strongest." His views dominated France with fierce destructive force, and ruin and overthrow were the results of his insane intensity of speculative power unguarded by the calm logic of practical responsibility. His was one of the least manageable and most morbid minds nature ever made, and made to love itself. "La Nouvelle Héloise" (1761), with great beauties and great defects, is full of the very intoxication of passion—a touching story carried on to an equivocal end. "Emile" is singularly acute, brilliant, and yet fanciful, if not chimerical. His "Devin du Village" is an opera, of which both words and music are his own. In England—under the kindly provision made for him by David Hume—he wrote those marvellous monomaniacal "Confessions" of which Madame de Boufflers remarked, "He would have borne a high reputation for virtue had he never written them." It has been affirmed that "there is more vanity concentrated in its first ten lines than in the whole contents of any other book in the world." Yet it is the most original, interesting and touchingly poetic of all his writings. He died on 3rd July, 1778.

Voltaire, the historian of "Le Siècle de Louis XIV.," was born at Châtenay, near Sceaux, on the 20th of February, 1694, and had not come of age when that great sovereign died. His father, François Arouet, who held office in the financial department, placed François-Marie in the Jesuit college of Louis le Grand. There he distinguished himself by aptitude in learning, sneering wit, and a scoffing tongue. Early taken into courtly circles, he acquired skill in compliment and repartee. After serving a short time in a lawyer's chambers he deserted Themis, and on [a wrongful] suspicion of being the author of some indecent satirical verses "On the Death of Louis XIV.," was imprisoned for a year in the Bastille. There he finished his tragedy "Œdipe," and planned "La Henriade." His father finding him unmanageable, from his association with aristocratic rakes, let him have his own way, and Arouet took the name of Voltaire. "Œdipe" (1718) was successful and put money in his purse. "La Henriade" was issued, he said, from a stolen MS., and with interpolations under the title of "La Ligne;" but this tricky way of gaining notoriety was too often employed by the author to make the story credible. In 1721 he visited Rousseau in Brussels, read to him his "Epître à Uranie," a compliment which Rousseau repaid by reading his "Ode to Posterity." Voltaire said it would never reach its address—and thereafter they were implacable foes. He was imprisoned again for challenging a man of quality, who had got his valets to beat the satirist. "Mariamne" appeared in 1724, and in 1726 he left France for England, where he lived in tolerable prosperity, and learned to use Shakespeare as a crib-book while he abused him as a playwright. Here he composed his tragedy of "Brutus," and sketched his "Lettres Philosophiques," called also "Lettres sur les Anglais." On returning to Paris Voltaire engaged in speculations in corn, in money-lending, and in lottery-tickets, and became rich. He also purveyed for the theatre, "Adelaide du Guesclin," and his dramatic masterpiece "Zaïre" (1732), &c., besides issuing at Rouen his "Histoire de Charles XII. de Suède"—a model of historic style and graphically recited details. He established in association with Madame du Châtelet a residence at the Villa of Cirey, and there wrote several of his best plays, "Alzire," "Mahomet," "Mérope," &c. Besides these he composed his "Siècle de Louis XIV." and "Essai sur les Mœurs et l'Esprit des Nations," written in an easy, lively, clear style, though his hatred of priestcraft carries him beyond reasonable bounds. In 1749 Voltaire settled in Berlin at the invitation of Frederick the Great for three years, where he, the eccentric, and the royal philosopher and poet found each other's company a weariness. The outcome was the "Annales de l'Empire," which most readers find tiresome. In 1758

Voltaire bought an estate at Fernay, near Geneva, and there, while pursuing his literary labours, the master of the mansion met the most celebrated thinkers and writers of Europe. There also he composed "L'Histoire de Pierre le Grand," "La Philosophie de l'Histoire," "L'Orphelin de la Chin," "Tancrède," &c. His "Discours sur l'homme" is founded on Pope's "Essay on Man." "The unrepentant apostle of unbelief," as he has been called, died in Paris, 30th May, 1778, was buried first in the Abbey of Scellières, and after the Revolution, his body having been exhumed, it was reinterred in the Panthéon in Paris. His writings occupy seventy vols. 8vo. It is impossible to characterize works so varied in manner and matter with any exactness in an epigram. His perspicacity and energy of language, aptness of epithet, neatness of style, fitness and harmony of period, profusion of thought, ease, brilliancy, and facility of composition, and an almost unparalleled industry must be acknowledged. His great defects are want of sympathy, simplicity, and sincerity. He possessed a destructive, but not a reconstructive, power of intellect. His emotions were easily stirred, but they were not strong. In antipathy he was implacable. His spirit was a mocking and disdainful one, and he may be regarded as the Mephistopheles of encyclopædism. He avowed the design of destroying Christianity, but he only knew it *en caricature*. His is the only French epic that can be named in comparison with those of the ancient singers and their modern emulators. Its subject is the taking of Paris by Henry IV. It displays more talent than genius, more brilliancy than inventiveness, and resembles history more than poetry. Its portraits are deficient in positive character, and the sentiments are overcrowded by the descriptive matter; but the diction is refined and terse. Some of his tragedies are as fine as any in the French language; his satires are witty, provocative of laughter, lively and terse; some of his smaller tales are entertaining and spirited, and his *histoires* are — except for their want of moral tone—well worthy of a high place among books of that class. Irascible malignity and irreverent mockery are too often shown in the works in which he deals with morality and religion.

Charles de Secondat, baron de Montesquieu, born 18th January, 1689, in the Castle of La Brède, near Bordeaux, was educated as a jurist and distinguished as a student. He succeeded, in 1717, to the family estate and to the presidency of the *parlément* of Bordeaux. His tastes inclined to the study of physical science, but till 1726 he fulfilled his legislatorial functions with diligence; then finding that his conscience would not permit him to sacrifice public business to private tastes, and his literary and philosophic designs growing more irrepressible, he resigned his chair. Five years before that he had issued his "Lettres Persanes," a work in which a Persian traveller describes the manners and government of Europe. By its peculiarly racy raillery of the vices and follies of his time, it attained great success. He became, in 1727, a member of the Academy, and thereafter spent several years in visiting different countries of Europe, that he might see for himself their condition and specialties. In 1734 he issued "Les Causes de la Grandeur et de la Decadence des Romains," an excellent exposition of the political and military system of Ancient Rome. With much care, unwearying labour, and profound thought, he devoted himself for the next twelve years to preparing his greatest work, "L' Esprit des Lois," a work which is designed to epitomize the legislative experience of mankind. It had an immense effect on political philosophy in Europe, and founded the school of inductive sociologists. This was his last great work; he died in 1755. In depth, originality, and refinement Montesquieu far transcends Voltaire, and must be regarded the greatest French writer on politics of his century.

Georges Comte de Buffon was born at Montbard, Burgundy, 1707, educated at the college of Dijon, and died 1788. He early manifested an interest in astronomy, and, while travelling in Italy, was struck with the signs of those convulsions and revolutions in nature which show themselves so palpably amid the scenery of that peninsula. Inheriting from his mother a fortune which allowed him to devote his mind to science, he was appointed, in 1739, curator of Le Jardin des Plantes, and was employed during the next ten years on his "Histoire Naturelle," a work which was received with admiration throughout Europe. He was nominated member of the Academy, and on his reception (25th August, 1753) delivered that "Discours sur Style" which justly ranks as one of the most celebrated of the orations delivered before it. It is remarkable both for grandeur of thought and splendour of language. His saying, "Le style est l'homme même," has passed into a proverb; by his "style" Buffon is immortal, and every student of French should peruse this graceful and ingenious performance.

NATURAL PHILOSOPHY.—CHAPTER XXIX.

VOLTAIC OR CURRENT ELECTRICITY.

PHYSICAL AND PHYSIOLOGICAL EFFECTS OF CURRENT—ELECTRIC OSMOSIS—ELECTRIC DISTILLATION—DIAPHRAGM CURRENTS—ELECTRO-CAPILLARITY—ACTION ON THE MUSCLES AND NERVES—ABSOLUTE ELECTRIC UNITS—ELECTROSTATIC UNITS—SPECIFIC INDUCTIVE CAPACITY CONSIDERED—SUBMARINE CABLES AS CONDENSERS—TRANSMISSION OF CURRENTS THROUGH INSULATED CONDUCTORS—RETARDATION OF CURRENT—USE OF CONDENSERS—ELECTRO-MAGNETICS—TUBES OF FORCE—INTENSITY OF MAGNETISM—MAGNETIC AND ELECTRO-MAGNETIC UNITS.

WHEN metal conductors are subjected to the lengthened action of electric currents, it is found that they undergo a gradual molecular change in their structure, and become brittle. The effect of the current is to lessen the cohesion of their molecules, and to decrease their coefficient of elasticity. Edlund supposed that in strained wires, when a current was transmitted through them, a slight elongation was observable; but at present it is undetermined whether this elongation may not be due to the heating effects of the current, owing to the resistance the wire offers to its passage, rather than directly due to the current itself.

The phenomena of electric osmosis is observed when a current of high potential is passed into certain fluids, a porous division separating the electrodes, the current then mechanically carrying a portion of the liquid through the porous diaphragm, and forcing it up to a higher level on one side than on the other. This effect is more apparent when liquids of low conducting power are employed as alcohol and bisulphide of carbon. The transfer of the liquid always takes place in the direction of the current, being higher at the kathode than at the anode.

The phenomenon of electric distillation observed by Beccaria, that an electrified fluid evaporated more rapidly than one not electrified, is closely connected with electric osmosis. In a bent closed tube containing two portions of a liquid, one highly + and the other highly −, the liquid will pass over from + to − by a slow transfer of the liquid along the interior surface of the tube. Bad conductors, as turpentine, will not pass over.

When a liquid is forced by pressure through a porous diaphragm a current is set up in the liquid, the electromotive force of which varies with the pressure and nature of the diaphragm. Water, when forced at a pressure of one atmosphere through a diaphragm of sulphur, gives a difference of potential of more than nine volts. Other diaphragms, such as porcelain and membrane, give differences of potential ·35 and ·01 volt respectively. When a horizontal glass tube turned up at the ends is filled with dilute acid, and a drop of mercury is placed at the middle of the tube, and a current sent through it, the mercury will travel along the tube towards the − end. An electro-motive force of $\frac{1}{300}$ volt is sufficient to produce a sensible displacement of the mercury. A capillary electrometer has been constructed by Dewar on this principle. The direction of the displacement varies with the direction of the current.

PHYSIOLOGICAL EFFECTS OF CURRENT.

If the electrodes of a powerful battery are held in the hands a violent shock is felt, which increases with the number of the elements, and if the potential of the current

is very high, may be even dangerous. In all cases the application of the current causes involuntary contractions of the muscles, and this contraction appears to be a very general property of protoplasm, the physical basis of both animal and vegetable life. The fresh muscle of a frog, which retains vitality for a length of time, exhibits no apparent effect so long as a current is passed continuously through it; but every make and break of the circuit causes a violent muscular contraction, as will also any sudden alteration in the potential of the current. The effect of the current upon living nerves is generally to throw the nerve into a state of activity. If the nerve be one belonging to a muscle, the effect will be the contraction of the muscle; if the nerve belong to the organs of sensation pain is produced; if one of special sense, the effect produced is the sensation of a flash of light, or that of taste, &c., according to the nerve under treatment. These effects are only produced when the current is interrupted suddenly, either closed or opened. Professor Burdon-Sanderson has demonstrated that the movements of the Venus' fly-trap (*Dionæa muscipula*), one of the so-called carnivorous plants, by which it closes its hairy leaves, entrapping insects which alight on it, is accompanied by an electric current, and the action is similar to that of involuntary muscular contraction.

Du Bois Raymond has shown that the contraction of muscles likewise produces electric currents; dipping the tips of his forefingers into two cups of salt water in connection with a galvanometer, a sudden contraction of the muscles of either arm set up a current from the contracted towards the uncontracted muscles. Dewar has also shown that the effect of light falling upon the retina of the eye is to set up an electric current in the optic nerve, due to its contraction.

ABSOLUTE UNITS OF ELECTRICAL MEASUREMENT.

The units of electrical measurement, already described (page 1218), are of a relative nature only, describing each magnitude dealt with by comparison with some other magnitude of like nature taken as a standard. The importance, however, of having a uniform system of measurements for *all* physical magnitudes, induced the British Association to adopt the system of "absolute units," known as the C. G. S. system, because it is based on the *centimètre* as the unit of length, the *gramme* as the unit of mass, and the *second* as the unit of time.

For the purpose of electrical measurement two sets of electrical units have been derived from these fundamental units. One set, that of *electrostatic* units, is based upon the force exerted between two quantities of electricity; the other, the *electro-magnetic* units, upon the force exerted between two magnetic poles. Electrostatic units of *quantity*, *potential*, and *capacity* may be briefly summarized as follows:—

ELECTROSTATIC UNITS.

The *unit of quantity* is that quantity of electricity which, when placed at a distance of a centimetre in air from a similar and equal quantity, repels it with a force of one *dyne*.*

The *unit of potential* is the amount of work done in moving a unit of + electricity against the electric forces, and is measured by the *erg* or unit of work (a dyne moved through a centimetre). Unit difference of potential exists between two points, when it requires the expenditure of one erg of work to bring a unit of + electricity from one point to the other against the electric force.

Unit of Capacity.—A conductor possesses unit capacity, which requires a charge of one unit of electricity to raise it up to unit potential. An insulated conducting sphere of the diameter of one centimetre has unit capacity when free from the influence of induction by other bodies.

Specific inductive capacity is the ratio between two quantities of electricity. The specific inductive capacity of air is taken as unity.

The *dimensions* of electrostatic units are the relations in which they stand to the fundamental units, and will be seen in the following table:—

	Units.						Dimensions.
	Fundamental:						
l	Length, ...						L
m	Mass, ...						M
t	Time, ...						T
	Derived:						
	Area	=	L	×	L	=	L^2
	Volume	=	L	×	L × L	=	L^3
v	Velocity	=	L	÷	T	=	$L T^{-1}$
a	Acceleration	=	velocity	÷	time	=	$L T^{-2}$
f	Force	=	mass	×	acceleration	=	$M L T^{-2}$
	Work	=	force	×	length	=	$M L^2 T^{-2}$
	Electrostatic:						
q	Quantity	=	$\sqrt{\text{force} \times (\text{distance})^2}$			=	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-1}$
i	Current	=	quantity	÷	time	=	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$
V	Potential	=	work	÷	quantity	=	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$
R	Resistance	=	potential	÷	current	=	$L^{-1} T$
C	Capacity	=	quantity	÷	potential	=	L
k	Specific inductive capacity	=	quantity	÷	another quantity		a numeral
	Electro-motive intensity	=	force	÷	quantity	=	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$

The capacity of a Leyden jar or other condenser depends upon the size of the conducting surfaces, the thinness of the glass or dielectric separating them, and the particular inductive capacity of the dielectric used.

As the capacity of a conductor is measured by the quantity of electricity necessary to raise its potential to unity; that is, if a quantity of electricity, Q, raise its potential from V to V′, its capacity is $C = \frac{Q}{V' - V}$.

The Leyden jar, or any other condenser, being virtually a conductor in which the conducting surface can be made to hold a large quantity of electricity without its potential, either + or − rising very high, the capacity of a condenser, like that of a simple conductor, will be measured by the quantity of electricity required to produce unit rise of potential.

If a Leyden jar is conceived to be composed of two concentric metal spheres, one inside the other, the space between them being filled with air, the inner one, which may be called A, will represent the interior lining of tinfoil, and the outer one, B, the exterior coating; and if the radii of these two spheres be respectively r and r', when a + charge of Q units is imparted to A, it will induce on the inner side of B an equal negative charge, − Q,

* A *dyne* is that force which, acting on one gramme for a second, imparts to it a velocity of one centimetre.

and to the outer side of B a charge $+Q$ will be repelled. This charge is withdrawn by contact with the earth. The potential at the centre, M, of the inner sphere A will then be represented by $V_M = \frac{Q}{r} - \frac{Q}{r'}$. At any point, N, outside the sphere B, and quite close to it, the potential will be the same as if these two charges, $+Q$ and $-Q$, were both concentrated at M. Therefore $V_N = \frac{+Q-Q}{r'} = 0$. The difference of potentials is therefore $V_M - V_N = \frac{Q}{r} - \frac{Q}{r'} = Q\left(\frac{r-r'}{r\,r'}\right)$. But as the capacity $C = \frac{Q}{V_M - V_N}$, therefore $C = \frac{r\,r'}{r'-r}$. So that the capacity of the condenser is proportional to the size of the metal globes, and if the insulating layer is very thin (that is, if r be nearly as great as r'), then $r'-r$ will become very small, and $\frac{r\,r'}{r'-r}$ will become very great. From this it appears that the capacity of a condenser depends upon the thinness of the layer of the dielectric.

That the capacity of a condenser did not depend alone on its actual dimensions, but also upon the inductive power of the material used as the dielectric between the two conducting surfaces, was first discovered by Cavendish. Thus, if two condensers are constructed of the same size, and in one the dielectric is a layer of air and in the other a layer of some other insulating substance, when equal charges of electricity are imparted to them they will be found not to produce equal differences of potential; that is, they have not the same capacity. This ratio between the capacities of two condensers of equal size, but with different specified dielectrics, one being air, Faraday termed *specific inductive capacity.* Recent researches, especially with reference to the insulation of submarine cables since 1870, have largely increased the knowledge of the inductive capacity of various substances; but owing to the phenomenon of electrical absorption the values depend upon the duration of the actual charge, instantaneous inductive capacity being different from the capacity of the substance when measured slowly. The instantaneous inductive capacity of the following substances, as determined by Gordon, are:—

Air,	1·00	Gutta-percha,	2·284
Paraffin, solid,	1·9936	Sulphur,	2·58
India-rubber,	2·220 to 2·497	Shellac,	2·74
Ebonite,	2·284	Glass,	3·013 to 3·258

LIQUIDS AND GASES.

Bisulphide of carbon,	1·81	Hydrogen,	0·9998
Petroleum,	2·03 to 2·07	Carbonic acid,	1·0008
Turpentine,	2·16	Olefiant gas,	1·000722
Air vacuum,	0·9985	Sulphur dioxide,	1·0037

Various important phenomena come into action in the passage of an electric current through an insulated circuit, such as a submarine cable. By induction an electric current is produced of an opposite character to that of the current moving through the insulated conductor in the adjacent water. The effect of this induced current is to retard or pull back the flow of the primary current, sensibly diminishing the speed of transmission as compared with that of a land line of telegraph. On a land line with a single wire the effect of induction does not take place, because the metallic conductor, generally iron, requires no insulating medium to inclose it, the air itself taking the place of the insulator. Induction, however, takes place with land wires when two or more are suspended closely together on the same support, or even on adjacent supports; a current through one wire will then produce an induced current of an opposite character in the adjacent wire. The submarine telegraph cable acts as a condenser, the ocean forming the outer coating, the internal conducting wire the inner coating, and the insulating layers of gutta-percha the dielectric of the Leyden jar. Insulation may be obtained by a very thin covering of the insulating medium: increase in the thickness only mechanically renders the covering more secure. The effects of induction, however, are decreased in proportion as the thickness of the insulating substance is increased, the conducting wire remaining the same. With an infinite insulation like the atmosphere induction would cease. With all insulated wires absorption takes place. Thus, when an electric current passes through an insulated metallic conductor, resistance occurs which impedes the direct progress of the current; induction takes place, or the setting up of a counter current in the opposite direction, and exerting, as it were, a pulling back of the original current, absorption is engendered, or the sucking up into the substance of the insulating medium of a sensible part of the original current, the result being that instead of the current passed into the wire at one end flowing through and emptying itself out at the other end of the wire, the current will flow out and leave a residue behind, an appreciable time being required for discharge to clear the line. Thus this absorption of the current leaves the line clogged for the receipt of the following current, and greatly interferes with the rapid transmission of signals through insulated metallic circuits. It is only therefore in very short cables that the speed of the transmission of the current can be considered instantaneous.

Since the speed of signalling, and therefore the economical
working through a cable, depends upon its capacity as a con-
denser, and since its capacity depends upon the specific
inductive power of the insulating material employed, Hooper's
compound of india-rubber and sulphur, and Henley's india-
rubber preparation, which have both a specific inductive
capacity of only 1·7 (as compared with gutta
generally preferred. The cables between lengthened action
and Denmark, and between Peterhead undergo a gradual
through the Baltic to Russia, and other ad become brittle.
structed of the Hooper core; the cable e cohesion of their
east coast of South America, river Plate, cient of elasticity.
Henley core. es, when a current

To avoid this retardation and increase elongation was ob-
ling in cables, various devices are emplo mined whether this
receiving instruments are used, such as ating effects of the
mirror galvanometer, represented as used offers to its passage,
in fig. 11, Plate XXV., which require only a f tself.
the actual charge given to the cable is re is observed when a
reversing key is employed, which, after into certain fluids,
ately sends into the cable a charge of o ectrodes, the current
out or neutralize, as it were, the charge le of the liquid through
signalling the resistance and electrostati up to a higher level
have to be compensated by balancing ag effect is more apparent
cable, consisting of a coil of wire of e wer are employed as
condenser of equal capacity. The Atla e transfer of the liquid
with a condenser containing 100,000 of the current, being
acres of tinfoil. Similar condensers ode.
employed on telegraph cables in single lation observed by Bec-
earth currents. Condensers of this ki ated more rapidly than
placing sheets of tinfoil between alterna d with electric osmosis.
paper, the alternate sheets of tinfoil bei portions of a liquid, one
Small condensers of similar constru he liquid will pass over
connection with induction coils. of the liquid along the
conductors, as turpentine,

ELECTRO-MAGNET

The relation between electric curr essure through a porous
termed electro-magnetics. Magneti the liquid, the electro-
is the work that must be spent the pressure and nature
N-seeking pole in bringing it up n forced at a pressure of
infinite distance. From a single m ragm of sulphur, gives a
from all other poles, the lines of e than nine volts. Other
directions, so that the surrounding and membrane, give differ-
into a number of conical regions, w volt respectively. When a
and through each cone, as throug up at the ends is filled with
of lines of force will pass. Such ury is placed at the middle of
tubes of force; consequently, the through it, the mercury will
across any section of a tube of the − end. An electro-motive
lines diverge more widely as the to produce a sensible displace-

Every magnet is surrounded apillary electrometer has been
within which magnetic force is f his principle. The direction of
field at any point is measured b the direction of the current.
on a unit magnetic pole placed

EFFECTS OF CURRENT.

of magnetic metal is placed in
lines of force run through it a owerful battery are held in the
of its magnetism depends upon felt, which increases with the
ad if the potential of the current

upon the metal itself. A metal in which a high magnetization is produced, like soft iron, is said to possess a high coefficient of magnetization. Substances which have a high coefficient of magnetization are therefore said to be good conductors of magnetism. The intensity of magnetization through the substance of a magnet is measured by dividing its magnetic moment (which is the product of the strength of either pole by its length) by its volume. There is, however, a certain maximum of intensity of magnetization for each magnetic metal, which can never be exceeded. Thus the maximum intensities of the following magnetic metals are—

Iron and steel,	1300
Cobalt,	800
Nickel,	494

Steel does not retain all the magnetism temporarily induced in it, its permanent maximum of intensity being only 785. From Gauss's observations the intensity of magnetization of the earth is 0·0790, or only $\frac{1}{17000}$ of what it would be if it were wholly of iron.

All magnetic quantities, strength of poles, intensity of magnetization, &c., are expressed in special units derived from the fundamental units of length, mass, and time, as follows:—

	Units.				Dimensions.
	Magnetic.				
m	Strength of pole / Quantity of magnetism	=	$\sqrt{\text{force} \times (\text{distance})^2}$	=	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-1}$
V	Magnetic potential	=	work ÷ strength of pole	=	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$
H	Intensity of field	=	force ÷ strength of pole	=	$M^{\frac{1}{2}} L^{-\frac{1}{2}} T^{-1}$
	Electro-magnetic.				
i	Current (strength)	=	intensity of field × length	=	$M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$
Q	Quantity	=	current × time	=	$M^{\frac{1}{2}} L^{\frac{1}{2}}$
V / E	Potential / Electro-motive force	=	work ÷ quantity	=	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$
	…sistance	=	electro-motive force ÷ current	=	$L T^{-1}$
	…pacity	=	quantity ÷ potential	=	$L^{-1} T^2$

…rs forefingers…
with a galvanome…
either arm set up…
uncontracted musc…
of light falling up…
electric current in he dimensions of electrostatic units with

ABSOLUTE UN… electromagnetic units, it will be seen that

The units of el… gned to similar units are different in the
(page 1218), are c…
magnitude dealt wi…

		Electro-static.	Electro-magnetic.	Ratio.
	Fundam…	$L^{\frac{3}{2}} T^{-1}$	$M^{\frac{1}{2}} L^{\frac{1}{2}}$	$LT^{-1} = v$
l	Lengt…	$L^{\frac{1}{2}} T^{-1}$	$M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$	$L^{-1} T = \frac{1}{v}$
m	Mass,			
t	Time,	L	$L^{-1} T^2$	$L^2 T^{-2} = v^2$
	Derived:	$^{-1}$ T	LT^{-1}	$L^{-2} T^2 = \frac{1}{v^2}$
	Area			
	Volum…			
v	Velocit…			
a	Acceler…			
f	Force			
	Work			
	Electrosta…			
q	Quantity			
i	Current			
V	Potentia…			
R	Resistan…			
C	Capacity			
k	Specific in…			
	Electro-mot…			

…s of quantity in electrostatic measure
…n electro-magnetic measure are $M^{\frac{1}{2}}L^{\frac{1}{2}}$.
by the latter the quotient is LT^{-1}, a
…he nature of a *velocity*. This velocity
in the ratio of the electrostatic to the
…ure of every unit. It represents that
…electrified particles must travel along
… that their mutual electro-magnetic
…al their mutual electrostatic repulsion.
…een measured in various ways, and
…tly the velocity of light.

…CTRO-DYNAMICS.

… in a state of motion, or the action
… each other and upon magnets,
…o-dynamics, the laws of electricity
… investigated under the name of

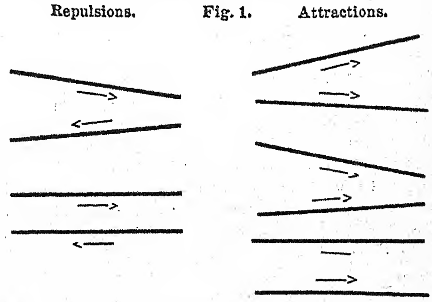
The capacity of a Leyd… st investigated, in 1821, the action upon the size of the condu… each other and upon magnets, glass or dielectric separati… overy of the action of a current ductive capacity of the diel… henomena depend upon the laws

As the capacity of a cond… order to examine these laws the of electricity necessary to ra… verses must consist of two parts, if a quantity of electricity, Q… ble.

its capacity is $C = \dfrac{Q}{V' - V}$. …circuit which are parallel, and … flowing in the same direction,

The Leyden jar, or any ot… the currents flow in opposite conductor in which the cond… her. This law is true whether hold a large quantity of el… s of two different circuits, or either + or − rising very high… uit. The several coils of a spiral coil when traversed by a current therefore attract one another, and the spiral shortens, because the current moves in the same direction in adjacent parts of the coil. Two non-parallel currents (fig. 1) attract each other if both

Repulsions. Fig. 1. Attractions.



are approaching or receding from the direction of the apex of the angle formed by the ends produced, while they will repel each other if one of the currents approach and the other recedes from the apex of the angle.

The second law, therefore, states that two portions of circuits crossing one another obliquely attract each other if both the currents run either towards or from the point of crossing, and repel one another if one runs to and the other from that point.

The third law is, that when an element of a circuit exerts a force on another element of a circuit, that force always tends to urge the latter in a direction at right angles to its own direction.

The fourth law is, that the force exerted between two parallel portions of circuits is proportional to the product of the strengths of the two currents, to the length of the portions, and inversely proportional to the distance between them.

For the purpose of observing these attractions and repulsions Ampère constructed the apparatus (fig. 2) known as Ampère's table, consisting of a double supporting metal stand, $v\,t$, terminating in two mercury cups, $x\,y$. Conductors formed of wire, twisted and shaped in different ways, are suspended in such a manner from the mercury contacts, $x\,y$, as to be capable of rotation. By means of this apparatus Ampère demonstrated the following:—

1. A circuit returned back upon itself, so that the current

flows back along a path close to itself, exerts no force upon external points.

2. A circuit bent into sinuosities or angular shapes produces the same magnetic effects on an adjacent portion of circuit as if it were straight.

3. In no case is any force exerted tending to move a conductor in the direction of its own length.

4. The force developed between two conductors of any form is the same, whatever the linear size of the system, provided the distances be increased in the same proportion, and that the potential of the currents remain unaltered.

In order to give the movable conductor more perfect freedom of motion than in Ampère's table, De la Rive contrived his floating battery. It consists (fig. 3) of a cork

Fig. 2.

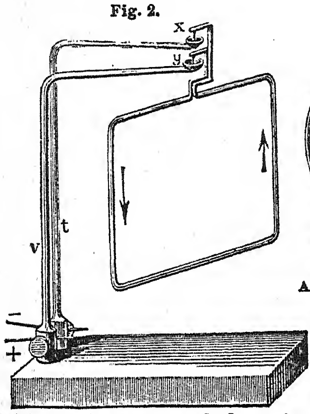
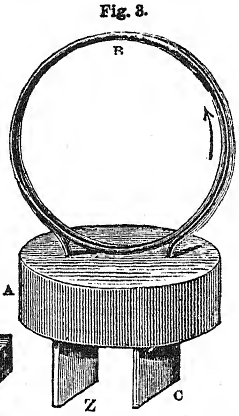
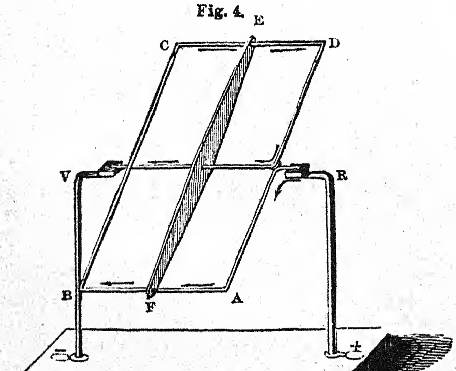


Fig. 3.



float, A, having attached to it a small voltaic element, consisting of a plate of zinc, Z, and one of copper, C. The conducting wire, B, joining the two plates, is insulated with silk and shellac, and formed into a ring of several coils of the wire. On placing the apparatus afloat in acidulated water voltaic action is set up, and the coil will have a tendency to take a position with its axis in the plane of the magnetic meridian, and will exhibit all the effects of magnetic attraction and repulsion when a bar magnet is brought near it on either side. Ampère likewise demonstrated that if a rectangular wire, A B C D (fig. 4), be arranged so as to be movable round a horizontal axis, and in perfect equilibrium in every position round the axis, the wire being kept in position by the wooden needle E F, the moment a current is established through the wire from the + to the − pole, R V, it begins to oscillate, and if placed with its axis of motion at right angles to the magnetic meridian finally takes up a position in the plane of the

Fig. 4.



magnetic equator. On reversing the current the magnetic polarity of the wire becomes reversed, and the rectangle turns round, placing itself in the same plane as before, but with its faces turned in the opposite direction.

Continuous rotation can be produced between a magnet and a circuit, or between two parts of one circuit, provided that one part of the circuit is movable while the other part remains fixed, or that the current in one part can be reversed. This latter arrangement is made use of in the construction of electro-magnetic engines. In the same manner that the wire revolves round the magnetic pole, the magnetic pole will revolve round the wire. In the centre of the bottom of a cup (fig. 5) a copper wire, C *d*, is inserted, to which a cylindrical magnet, N S, is attached by a thread, and the cup is nearly filled with mercury, so that only the N. pole of the magnet projects. A conductor, *a b*, is then fixed in the mercury perpendicularly over C. On sending a current through the conducting wires, *a b* and C *d*, it will be transmitted from one wire through the mercury to the other. When

Fig. 5.

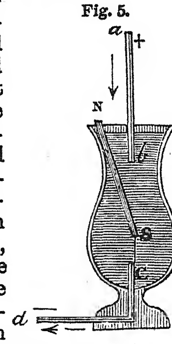
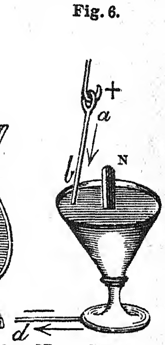
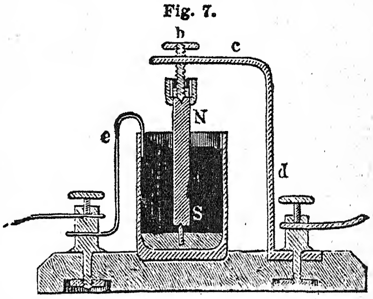


Fig. 6.



the + current passes down from *a b*, the N. pole of the magnet immediately rotates from east to west, in the direction of the motion of the hands of a watch. If the current ascend, then the direction of rotation is reversed. Conversely a magnet, N (fig. 6), is fixed into a vessel filled with mercury, and the conducting wire, *a b*, hung from a hook above it, the end just dipping into the mercury. The current, on being transmitted through this movable conductor, will cause the free end to revolve round the pole, N, of the magnet in a direction from east to west. The direction of the rotation imparted by a fixed current to a movable pole is the same as that which the same pole imparts to the same current. A vertical magnet, N S (fig. 7), pivoted at *b* so as to turn around its own axis, will also rotate when a current is led into its middle region by the conductor, *e*, and out at either end, as *b c d*. If the current is passed through the two ends there will be no rotation, the two poles being urged to rotate in opposite directions.

Fig. 7.



Liquid conductors likewise exhibit the phenomena of electro-magnetic rotations. If a cylindrical metallic vessel, filled with mercury or dilute acid, be connected to one pole of a battery, and a wire from the other pole is dipped into its middle so that a current may flow radially from the centre to the circumference, or *vice versâ*, then if the vessel be placed on the pole of a powerful magnet, or if a magnet be held over it vertically, the liquid will be seen to rotate.

The electro-dynamometer is an instrument devised by Weber for measuring the strength of currents by means of the electro-dynamic action of one part of the circuit upon another part. It is a kind of galvanometer, in which, in place of a magnetic needle, there is a small coil suspended. One form of instrument consists of two large parallel coils of several revolutions of insulated wire. The inner small coil also consists of two parallel coils; this is suspended by two fine parallel metal wires between the two outer coils with its axis at right angles to that of the other coils. If a current flows round both coils in either direction, the inner bobbin tends to revolve and place its coils parallel to the outer coils, the sine of the angle through which the suspending wires are twisted being proportional to the square of the strength of the current. The great advantage of this instrument over a galvanometer is that it can be employed for induction currents in which there are very rapid alternations, a current in one direction being followed by a reversal, often thousands of times in a minute. Owing to

the slowness of the swing of a needle, such currents are scarcely indicated by a galvanometer. Electro-dynamometers are employed, constructed with coils of very thick wire, for the absolute measurement of strong currents, such as are used in producing the electric light, and are also frequently used as power meters to measure electric horse-power evolved by a battery or consumed in an electric lamp or machine.

To explain this action of currents upon currents Ampère suggested a theory, assuming that, in the case of these forces acting apparently at a distance across space, the action took place in straight lines between two points, the total attraction being the sum of the separate attractions on all the different parts. Faraday's researches have, however, demonstrated facts from which the mutual attractions and repulsions of currents are now regarded as being due to actions taking place in the medium which fills the space around and between the conductors. This space is regarded as being full of curving "lines of force." Every wire passing a current has a magnetic field surrounding it, and every closed circuit acts as a magnetic shell. Therefore all these electro-dynamic actions are capable of being regarded as magnetic actions.

Arago and Davy, shortly after Œrsted's discovery, independently found out how to magnetize iron and steel, by causing currents of electricity to circulate round them in spiral coils of wire. From the influence which currents exert upon magnets, turning the N. pole to the left, and the S. pole to the right, the inference naturally is that by acting upon a magnetic substance in the natural state the currents would tend to separate the two magnetisms. When a wire passing a current is immersed in iron filings, they adhere to it strongly, but so soon as the current ceases they become detached. The action of currents on magnetic substances is seen by coiling an insulated copper wire round a thin glass tube, as in fig. 8 annexed, in which an unmagnetized steel bar, S N, is inserted. On a current being passed through the wire in the direction a to b, even for a short time, the bar will be strongly magnetized, and in a right-handed helix or spiral (of which the common screw is an example) the N. pole is at the end at which the current leaves, and the S. pole at the end at which it enters; the reverse takes place with a left-handed helix, as in fig. 9. If the bar be of iron it will be a magnet only so long as the current flows; and an iron bar thus surrounded with a coil of conducting wire is called an electro-magnet. In order to magnetize the bar it is not necessary that it be placed in a tube; it is sufficient to coil round it a copper wire well insulated with silk or cotton, so as to multiply the action of the current, and thus a feeble current is capable of producing powerful magnetizing effect.

Fig. 8.

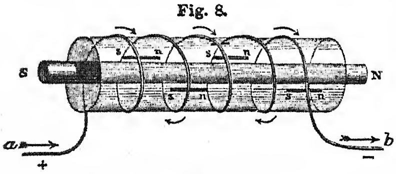
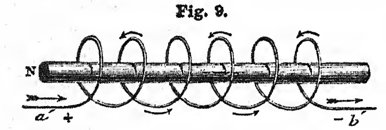
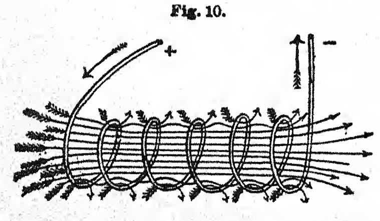


Fig. 9.



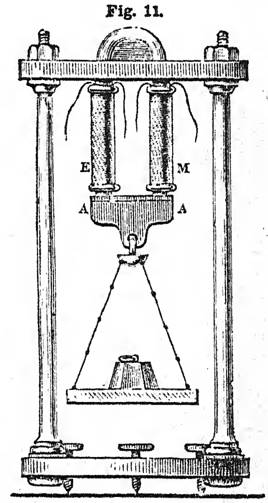
When a spiral coil of wire is traversed by a current it acts as an electro-magnet, but not so powerfully as when an iron core is inserted through it. A coil of this kind is termed a *solenoid*, and the annexed cut (fig. 10) represents by the arrows the lines of magnetic force which traverse it during the passage of the current. It has two poles and a neutral equatorial region; and it acts as a magnet in every respect. It also attracts another solenoid, and has a magnetic field generally resembling that of a bar magnet; and if so arranged that it can turn round on a vertical axis, it will assume a N. and S. direction along the magnetic meridian. As the same quantity of electricity flows round each loop of the spiral coil, the loops will be of equal magnetic strength, and the total magnetic strength of the solenoid will be exactly in proportion to the number of turns in the coil. If there be n turns, the number of magnetic lines of force traversing the solenoid will be n times as great as the number due to one single coil. The use of the iron core of an electro-magnet is to concentrate and increase, by its greater magnetic induction, the available number of lines of force at definite poles. The lines of force due to a current flowing in a wire are closed curves, approximately circles round the wire. When there is no iron core, a number of these small circular lines of force simply remain as small closed curves around their wire; but as iron possesses a high coefficient of magnetic induction, where the wire passes near the iron core the lines of force alter their form, and instead of remaining as little circles around the separate wires, run through the iron core from end to end, and round outside from one pole back to the other, as in a permanent magnet.

Fig. 10.



Electro-magnets have generally the horse-shoe form shown in fig. 11, where the armature A is represented supporting a weight. The principal laws of electro-magnets are:—

Fig. 11.



1. The magnetic strength of an electro-magnet is proportional to the strength of the magnetizing current, that is, to the quantity of electricity that circulates round it.

2. The resistance being taken into account, the electro-magnetic force is independent of the thickness and material of the conducting wire.

3. With the same current the strength of an electro-magnet is independent of the diameter of the coils, provided the iron core projects a little beyond the coils, and the diameter is small compared to its length.

4. The temporary magnetic strength of an electro-magnet is proportional (within certain limits) to the number of turns of wire in its coils. The greatest magnetizing power is obtained when the resistance in the magnetizing coil is equal to the sum of the other resistances in the circuit, those of the battery included, and the length and diameter of the wire must be so arranged as to satisfy these conditions.

5. The magnetism in solid and in hollow cylinders of the same diameter is the same, provided there is, in the case of the tube, sufficient thickness of iron for the development of the magnetism.

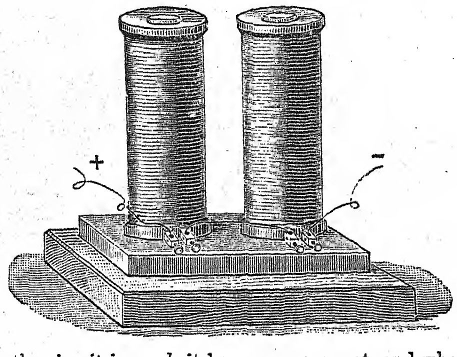
6. A current requires a sensible period of time to magnetize an iron core to the full extent of its power. The large electro-magnet at the Royal Institution, London, requires about two seconds to attain its maximum strength. Beetz made the observation that, for the same strength of current, the magnetization of the core is more rapidly established in circuits with great resistance and great electro-motive force, than in circuits with small resistance and correspondingly smaller electro-motive force.

In the construction of electro-magnets it is usual to divide the coils into two parts. In order that the two ends of the horse-shoe may be of opposite polarity, the winding on the two poles must be such that if the horse-shoe were straightened out, it would be in the same direction. Electro-magnets, instead of being made in one piece, are frequently constructed of two iron cylinders, firmly screwed to a stout piece of iron (fig. 12). The coils on them must be such that the current shall flow in the same direction as the hands of a watch as

viewed from the S. pole, and against the hands of a watch as seen from the N. pole.

The great usefulness of the electro-magnet in its application to electric bells and telegraphic apparatus consists in the fact that its magnetism is under the control of the current;

Fig. 12.



when the circuit is *made* it becomes a magnet, and when the current is *broken* it ceases to act as one.

MEASUREMENT OF CURRENTS.

Ohm's law, so far, has been stated—that the strength of the current varies directly as the electro-motive force, and inversely as the total resistance of the circuit. By expressing the same in the units adopted, Ohm's law will be, that the number of amperes of current flowing through a circuit is equal to the number of volts of electro-motive force divided by the number of ohms of resistance in the entire current; that is, current $= \frac{\text{electro-motive force}}{\text{resistance}}$, or $C = \frac{E}{R}$. In practice, however, the calculation is not so simple, for when several cells are used, and the circuit is made up of a number of different sections, through all of which the current has to travel, the electro-motive forces of the cells, their resistances, and the resistances of the various parts of the circuit have all to be calculated. If all the values of the several electro-motive forces and of all the resistances are known, the current would have for its value

$$C = \frac{e' + e'' + e''' + e'''', \text{ \&c.}}{r' + r'' + r''' + r'''', \text{ \&c.}} = \frac{\text{total electro-motive force}}{\text{total resistance}}.$$

In practice, however, a cell may be placed so that its electro-motive force would oppose that of the other cells: an opposing electro-motive force must therefore be subtracted. The polarization which takes place in battery cells after working some time is likewise an element of opposing electro-motive force, which diminishes the total effective electro-motive force of the whole circuit. Again, there is the induced opposite current from a battery when it drives a magneto-electric engine, also reducing the strength of the working current, and the loss from imperfect contacts and leakage.

The resistances in a circuit are usually of two kinds—first, the resistance of the conductors; second, that due to imperfect contacts at the various connections. This latter resistance is always variable, being affected by pressure. If the surfaces of two conductors are tightly in contact with one another, the current flows more freely than when the pressure is light. Contact resistance between two conductors will vary according to pressure from infinity down to a small fraction of an ohm.

The laws of the resistance of conductors are:—

1. The resistance of a conducting wire is proportional to its length, so that if the resistance of a mile of telegraph wire be 13 ohms, that of 150 miles will be 150×13 ohms$=1950$ ohms.

2. The resistance of a conducting wire is inversely proportional to the square of its diameter. Ordinary telegraph line wire has a diameter of a sixth of an inch, therefore a wire of twice that diameter would conduct four times as well, and an equal length would have only one-fourth of the resistance.

3. The resistance of a conducting wire of given length and diameter depends upon the material and its specific resistance. Copper wire, for instance, varies in its conductivity considerably. The conductivity of pure copper being taken at 100, No. 16 B.W.G., used for ordinary bell-hanging, has frequently as low a conductivity as 37, while the same gauge of wire used for telegraph conductors has always as high a conductivity as 96.

The specific resistance of a conductor is generally stated as the resistance of a *centimetre cube of the substance*, in thousand millionths of an ohm.

The following are the specific resistances and relative conductivities of various substances, silver being taken at 100.

Substance.	Specific Resistance.	Relative Conductivity.
Metals.		
Silver, ...	1,609	100
Copper, ...	1,642	96
Gold, ...	2,154	74
Iron, soft, ...	9,827	16
Lead, ...	19,847	8
German silver, ...	21,170	7·5
Mercury, liquid, ...	96,146	1·6
Liquids.		
Pure water at 22° C., . . .	$7·18 \times 10^{10}$	less than one millionth part
Dilute sulphuric acid $\frac{1}{12}$ of acid, ...	$·332 \times 10^{10}$	
Dilute sulphuric acid $\frac{1}{3}$ of acid, ...	$·126 \times 10^{10}$	
Insulators.		
Glass, at 200° C., ...	$2·27 \times 10^{16}$	less than one billionth part.
Gutta-percha, at 20° C., . .	$3·5 \times 10^{23}$	

Those substances which possess a high electrical conductivity are also the best conductors of heat. Gases are non-conductors, unless so rarefied as to permit discharge by convection through them.

Changes of temperature temporarily affect the conducting power of metals. The resistance of iron increases considerably as the temperature is raised; copper and lead likewise show an increase; but, on the other hand, carbon becomes a better conductor on being heated. German silver and other alloys vary but little, and for this reason they are employed in making standard resistance coils.

An elementary circuit composed of a battery r (fig. 1, Plate XXVI.), the line represented by the resistance-box, R, and a galvanometer, G, joined up in circuit will give the following equation of Ohm's formula:—The total electro-motive force of the battery will be E, the total internal resistance of the fluid in the cells r, and the resistance of the galvanometer coils G. Therefore $C = \frac{E}{R + r + G}$. This internal resistance of the battery r has a very important relation to the external resistance of the circuit including R and G, as has already been shown. In telegraph work, where the instruments require a current of from 5 to 10 milliamperes to work them, and each instrument in the circuit has a resistance equal to 10 miles of wire, it is generally calculated that an additional Daniell cell is necessary for every 5 miles of line.

When a circuit is divided, as in fig. 2, Plate XXVI., where it separates into two branches at A, and unites again at B, the current is also divided, a portion flowing through one branch, A r B, and another portion through A r' B. The relative strengths of the two currents will be proportional to the conductivities of the two circuits; that is, inversely proportional to their resistances. If r be a wire of 3 ohms resistance, and r' 5 ohms, then the current in r : current in r' :: r' : r, or$=5:3$, or $\frac{5}{8}$ of the whole current will flow through r, and $\frac{3}{8}$ through r'. The joint resistance of the divided circuit between A and B will be less than the resistance of either branch singly, because the current has now a choice of either

VOLTAIC ELECTRICITY — MEASUREMENT OF CURRENTS.

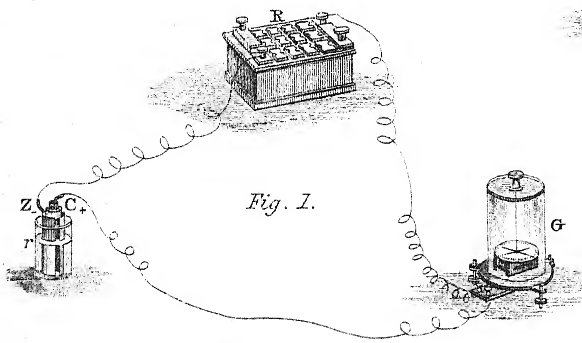


Fig. 1.

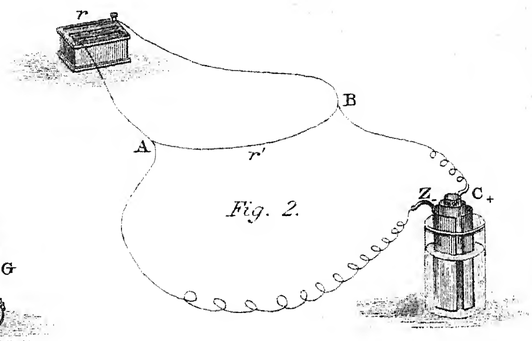


Fig. 2.

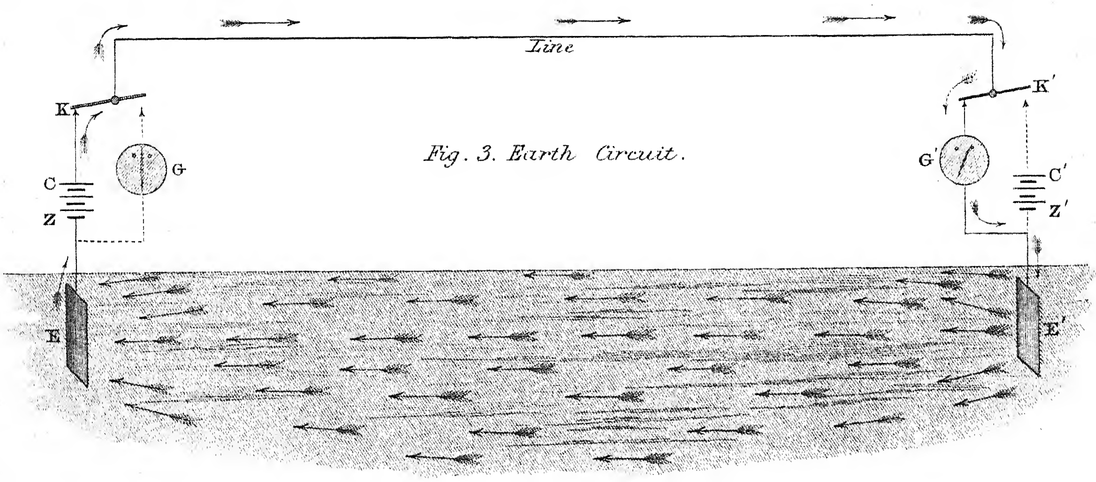
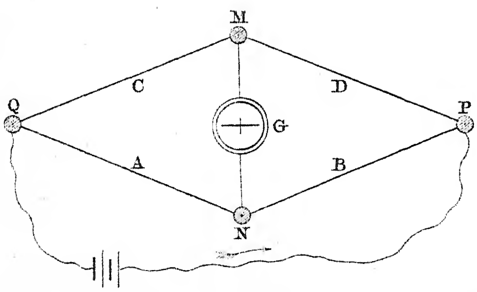


Fig. 3. Earth Circuit.



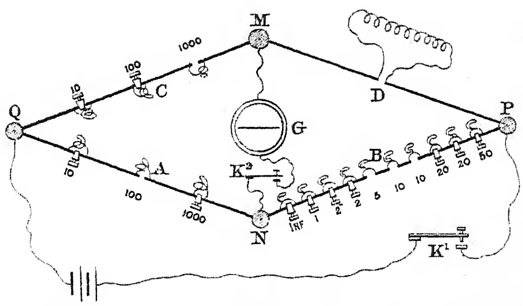


Fig. 4. Wheatstone's Bridge. Fig. 5.

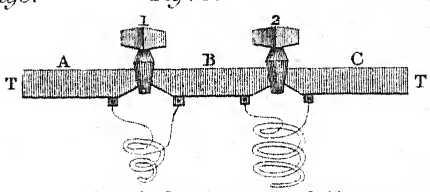


Fig. 6. Resistance Coils.

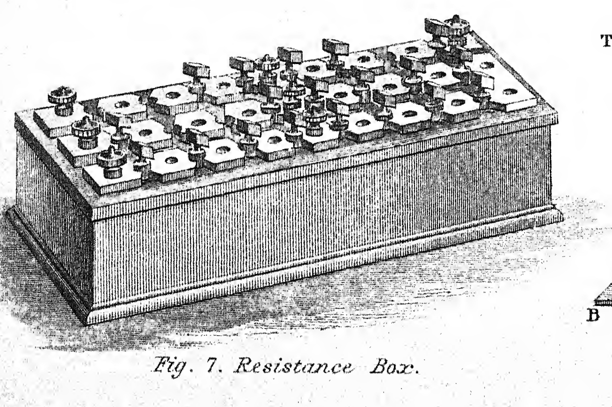


Fig. 7. Resistance Box.

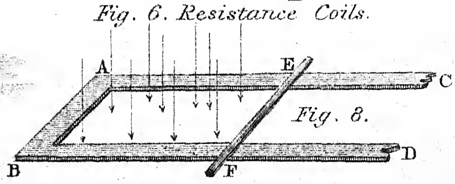


Fig. 8.

path, and the joint conductivity will be the sum of the two separate conductivities. If the joint resistance is R, then $\frac{1}{R}=\frac{1}{r}+\frac{1}{r'}=\frac{r'+r}{rr'}$; therefore $R=\frac{rr'}{r+r}$, or the joint resistance of a divided conductor is equal to the product of the two separate resistances divided by their sum. Kirchoff has deduced the two following important laws from Ohm's formula:

1. In every divided network of wire the algebraic sum of the currents in all the wires that meet in any point is zero.

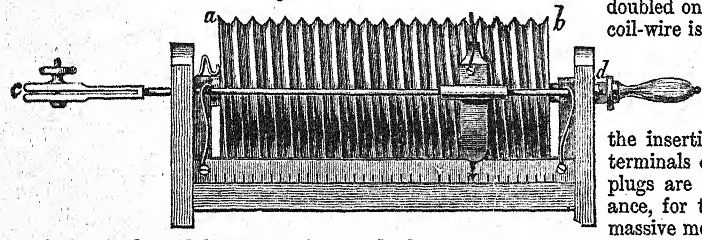
2. When there are several electro-motive forces acting at different points of a circuit, the total electro-motive force round the circuit is equal to the sum of the resistances of its separate parts multiplied each into the strength of the current that flows through it.

A current entering a solid conductor spreads out and flows through the mass of the conductor, but when a current flows into a thin plate of conducting material it spreads out into a *current sheet*, and flows through the plate in directions depending upon the shape of the plate and the position of the pole by which it returns to the battery. If the wires from the two poles of a battery are placed in contact with two adjacent points, A and B, upon the middle surface of a large sheet of tinfoil, the current will not flow through the foil in a straight line between A and B, but in curving lines which start out in all directions from A, and curve round again to meet in B. These curves resemble the lines of force that run from the north pole to the south pole of a magnet.

When the earth is used as a return circuit in telegraph circuits a similar spreading out of the current (fig. 3, Plate XXVI.) occurs.

The measurement of the electrical resistance, electro-motive forces, and the capacities of conductors is determined by comparison with ascertained standards, and may be varied as the circumstances require. As a method of comparison Wheatstone proposed to employ as a standard resistance a long thin wire coiled on a wooden cylinder *a b* (fig. 13) in spiral grooves,

Fig. 13.



so that any desired length of the standard wire might be thrown into the circuit, by making contact at some point at any desired distance from the end of the wire, the amount cut off being indicated by a scale. The connections for the circuit are shown at *c d*. This instrument is called a *rheostat*.

The most accurate way of measuring resistance, and that which is now usually employed, is with a set of standard *resistance coils* and the important instrument called the *Wheatstone Bridge*. The principle on which this is constructed is that if the electric potential of various points of a circuit be examined by means of a galvanometer it will be found to decrease all the way round the circuit, from the + pole of the battery, where it is highest, down to the − pole, where it is lowest. If the circuit consist of a wire of uniform dimensions which presents a uniform resistance to the current, the potential falls uniformly, but if one part of the current offers more resistance than another, then the potential falls most rapidly along the conductor of greatest resistance. In every case the fall of potential between any two points is proportional to the resistance between those two points, and at any point in a uniform circuit where the potential has fallen through half its value, the current has at that point passed through half the resistances.

The Wheatstone Bridge consists of a system of conductors. The circuit of a constant battery (fig. 4, Plate XXVI.) is made to divide at P into two parts, which reunite at Q, so that a part of the current flows through the point M and the other part through the point N. The four conductors, D, C, B, A, are termed the arms of the bridge, and it is by the proportion subsisting between their resistances that the resistance of one of them can be calculated when the resistances of the other three are known. When the current which starts from C, at the battery, reaches P, the potential will have fallen to a certain value. The potential of the current in the branch D falls again to M, and continues to fall to Q. The potential in the branch B falls to N, and again falls till it reaches the value at Q. Consequently, if N be the same proportionate distance along the resistances A and B, between P and Q, that M is along the other resistances, C and D, the potential will have fallen at N to the same value as it has fallen to at M; in other words, if the ratio of the resistance C to the resistance D be equal to the ratio between the resistances A and B, then M and N will be at equal potentials. It is usual to construct the bridge with some resistance coils in arms A and C, as well as with a complete set in the arm B, as shown in fig. 5. In order to determine the balance of potentials a sensitive galvanometer is introduced in a branch wire between M and N, showing when no deflection takes place that M and N are at equal potentials, or when the four resistances of the arms balance one another by being in the proportion A : C :: B : D. Consequently, knowing the values of A, B, and C, that of D can be calculated: $D=\frac{B\times C}{A}$. Thus, if A and C (fig. 5) are 100 ohms and 1000 ohms respectively, and B is 25 ohms, D will be $25\times 1000\div 100=250$ ohms.

A standard resistance is ordinarily a given length of a wire of a certain definite material, and is called a *resistance coil*. An alloy of silver with about one-third of platinum is the best material, the resistance varying little with increase of temperature. Coils of this wire (fig. 6, Plate XXVI.) wound with great care are adjusted to the requisite lengths to have resistances of a definite number of ohms, as 1, 2, 3, 4, 5, 10, 15, 20, &c. In order to compensate self-induction and the consequent sparks, they are covered with silk and shellac, and wound in the manner shown, each wire being doubled on itself before being coiled up. Each end of the coil-wire is soldered to a solid brass piece: coil 1 ohm to A and B, coil 2 ohms to B and C, and so on. These brass pieces are fixed to a block of ebonite forming the cover of the resistance series, with sufficient space between them for the insertion of stout well-fitting plugs of brass; if the terminals of a circuit are connected with T T and all the plugs are inserted, the coils offer no appreciable resistance, for the current passes through the plugs and the massive metal pieces A, B, C, but by removing any plugs the current can only pass from one brass piece to the others by traversing the coils thus thrown into circuit. Fig. 7, Plate XXVI. represents a set of resistance coils, the series of coils usually selected having the following number of ohms resistance:—1, 2, 2, 5; 10, 20, 20, 50; 100, 200, 200, 500; 1000, 2000, 2000, 5000, up to 10,000 ohms, which enables any resistance from 0·1 to 100 ohms to be introduced into the circuit. In the figure the resistance thrown into the circuit is 323 ohms.

Every resistance is capable of being expressed as a velocity. The dimensions of resistance are $L\,T^{-1}$, which are the same as those of a velocity. In a circuit composed of two horizontal bars, A C, B D (fig. 8), placed one centimetre apart, if A and B are joined, and the circuit completed by a sliding piece, E F, when this variable circuit is placed in a uniform magnetic field of unit intensity, the lines of force will be directed vertically downward through the circuit. If E F be moved along towards C D with a velocity of n centimetres per second, the number of the lines of force inclosed by the circuit will increase at the rate of n per second, consequently there will be an induced electro-motive force acting upon the circuit, which will cause a current to flow through the sliding piece from E to F. If the horizontal bars have no resistance, the strength of the current will depend on the resistance of E F. If its resistance be one absolute electro-magnetic unit, it need only move at the rate of one centimetre per second, in order that the current should be maintained at unit strength. If its resistance be greater, it must move with a proportionately greater velocity, as the velocity at

which it must move to maintain a current of unit strength is numerically equal to its resistance. The resistance of 1 ohm is equivalent to 10^9 absolute electro-magnetic units, and is therefore represented by a velocity of 10^9 centimetres, or 10,000,000 metres per second.

HEATING EFFECTS OF THE CURRENT.

An electric current may perform various kinds of work, chemical, mechanical, magnetic, or thermal, but in every case that work is performed by the expenditure of part of its energy. The strength of a current is diminished by whatever increases the external resistance, and whatever amount of current is not expended in external work is dissipated in heat. When matter in motion is arrested by friction the energy of its motion is converted into heat. When electricity in motion is arrested by resistance, the energy of its flow is likewise converted into heat. Heat appears wherever the circuit offers a resistance to the current. A powerful voltaic current passed through a thin metallic wire heats it white hot, and even melts it if the current be strong enough. All the metals have been melted by the heat of the electric current, carbon being the only element which, so far, has not been fused. The laws of the development of heat in metallic conductors have been investigated by Joule and Lenz, and determined to be as follows:—

The number of units of heat developed in a conductor is proportional to its resistance, to the square of the strength of the current, and to the time that the current lasts. Joule's law is expressed by the equation $H = C^2Rt + 0{\cdot}24$, where C is the value of the current in amperes, R the resistance in ohms, t the time in seconds, and H the heat in the unit of heat-quantities, which is the amount of heat required to raise 1 gramme of water through 1° C. of temperature. The formula is the expression of the fact that a current of 1 ampere flowing through a resistance of 1 ohm develops 0·24 heat-units per second.

The increase of temperature in a resisting wire is dependent on the nature of the resistance. A short length of thin wire may offer as much resistance as a long length of thick wire, and in each the same number of heat-units will be developed, but as in the thin wire the heat is expended in warming its small mass, it becomes very hot; while in the long thick wire the heat spread over the increased mass is imperceptible. If the wire weigh w grammes, and have a specific capacity for heat s, then $H = swx$, where x is the rise of temperature in degrees C.; therefore $x = 0{\cdot}24 \times \dfrac{C^2Rt}{sw}$. As the resistance of metals increases as they rise in temperature, a thin wire resists more and more, becoming hotter and hotter until its rate of loss of heat by conduction and radiation equals the rate at which the heat is supplied by the current. Thin wires heat very much more rapidly than thick wires, the increase of temperature in different parts of the same wire being for different thicknesses inversely proportional to the fourth power of the diameters. A thin platinum wire heated white hot by a current is frequently employed in place of a knife for surgical operations.

ARITHMETIC.—CHAPTER XIV.

RATIO AND PROPORTION EXPLAINED AND EXEMPLIFIED—THE RULE OF THREE—EXERCISES.

When we compare two magnitudes with each other, by finding the number of times that the one is contained in the other, that is, by dividing one of them by the other, the resulting quotient which we get is called their *ratio*. Thus 3 is the ratio of 12 to 4, since 3 is the quotient of 12 divided by 4. This is usually indicated by writing 12 : 4. It is manifest, however, in this mode of comparison, that we may either say the first of the numbers [12] is triple of the second [4], or that the latter [4] is a third [$\frac{1}{3}$] of the former, *i.e.* with equal correctness, call $\frac{1}{3}$ the ratio of 4 to 12. In this case we only suppose the *order* of division or comparison to be changed, and instead of considering 12 : 4 we take the quantity in the order 4 : 12, making it a general rule to divide the first of the numbers enunciated by the second. Ratio is, then, the relation which one quantity bears to another of the same kind with respect to magnitude; and the comparison is made by considering how often the one is contained in the other, or how often the one contains the other. The ratio of 12 to 3 is expressed by dividing 12 by $3 = \frac{12}{3} = 4$, ratio; or it may be expressed by dividing 3 by $12 = \frac{3}{12} = \frac{1}{4}$, ratio. The former is the method by which the English mathematicians express ratio, and the latter is the French method.

When the ratio of two numbers is the same as that of two others, these four quantities form a *proportion*, which results from the *equality* of two ratios. Thus the ratio of 15 to 5, and of 18 to 6, is 3. These numbers constitute a proportion, which may be written as follows:—

$$15 : 5 :: 18 : 6;\ 5 : 15 :: 6 : 18;\ \text{or}\ \tfrac{5}{15} = \tfrac{6}{18};\ \tfrac{15}{5} = \tfrac{18}{6}.$$

The first of these forms of expression is commonly used, although the last is, in some respects, the more convenient. The meaning given by each form of notation is, that the quotient of 15 divided by 5 is equal to the quotient of 18 divided by 6, *i.e.* the ratio of 15 to 5 is equal to the ratio of 18 to 6. But the formula of enunciation is this:—As 15 is to 5, so is 18 to 6; or, more shortly, 15 is to 5 as 18 is to 6. Proportion, then, is the likeness or equality of ratios. Thus, because 15 has the same ratio to 5 that 18 has to 6, we say such numbers are in *proportion* to each other, and they are called *proportionals*.

$$\overbrace{15 : \underbrace{5 :: 18}_{90} : 6}^{90} \qquad \overbrace{4 : \underbrace{8 :: 3}_{24} : 6}^{24}$$

The four numbers b g proportioned in the order written, the terms 15 and 6 called the *extremes*, and 5 and 18 the *means* of the p tion; and since $\frac{15}{5} = \frac{18}{6}$, it follows from the nature of fr ons (see p. 512) that $15 \times 6 = 5 \times 18$, that is, the product of the extremes is equal to the product of the means. On the same principle we may multiply or divide the pairs of terms 15 and 5 and 18 and 6, by any numbers without destroying the *equality* of their ratios. Thus, multiplying the first pair by 2, and dividing the second pair by 3, we obtain the proportion 30 : 10 : : 6 : 2, the common ratio of which is 3, as before. As the product of the extremes is still equal to the product of the means, the proportion is not destroyed. Whenever four numbers are proportionals, if their antecedents or consequents be multiplied or divided by the same numbers, they are still proportionals; and if the terms of one proportion be multiplied or divided by the corresponding term of another proportion, their products and quotients are still proportionals. The student will find it useful to convince himself of the correctness of this principle by examining carefully the following examples of equivalent changes:—

4	: 8	: : 3	: 6	(direct).
8	: 4	: : 6	: 3	(inverted).
4	: 3	: : 8	: 6	(permuted).
4+8	: 8	: : 3+6	: 6	(compounded).
4	: 4+8	: : 3	: 3+6	(compounded).
4	: 8−4	: : 3	: 6−3	(divided).
8−4	: 8	: : 6−3	: 6	(divided).
4×4	: 8×8	: : 3×3	: 6×6	(compounded).
$\frac{4}{3}$	: $\frac{8}{6}$	: : $\frac{3}{4}$	: $\frac{6}{8}$	(divided).

If, then, one of the extremes be wanting, divide the product of the means by the extreme given; or if one of the means be wanting, divide the product of the extremes by the means given, and the result will be the term sought; *e.g.*—

6 : 18 : : x : 6	$x = 2$.
5 : 20 : : 12 : x	$x = 48$.
x : 20 : : 3 : 6	$x = 10$.
2 : x : : 15 : 45	$x = 6$.

From this condition of the equality of the products of the extremes and means, it follows that the fourth term of any proportion must be equal to the quotient resulting from the division of the product of the means by the first term; *e.g.* in 30 : 10 : : 6 : 2 the product of the means is

10×6, or 60, and the quotient of 60 by 30, the first term, is 2, the last term. If, then, the last term of a proportion be wanting, it may be found by a process of multiplication and division. This simple process constitutes the rule in commercial arithmetic popularly called the Rule of Three, because in it (1) three quantities are given, and (2) a fourth is to be found. Take as an illustration:—

An engineer having finished 100 yards of work in a certain number of days with 5 men, how many yards of a like quality of work may he finish in the same time with 8 men?

Here there are two quantities of the same sort, namely, 5 men and 8 men; and a third of another sort, namely, 100 yards, but the answer required by the question is of the same nature as this last, namely, yards. Let therefore this number of yards be, in the meantime, denoted by x. Then, that these four terms may constitute a proportion, the ratios of the pairs must be equal to each other; that is—

$$\overset{\text{Men.}}{5} : \overset{\text{Men.}}{8} :: \overset{\text{Yards.}}{100} : \overset{\text{Yards.}}{x}; \text{ that is, } x=\frac{8\times 100}{5}=160,$$

dividing the product of the two means by the first term. The quantity x is therefore equal to 160 yards, the fourth term of the proportion, which will now stand:—

$$\overset{\text{Men.}}{5} : \overset{\text{Men.}}{8} :: \overset{\text{Yards.}}{100} : \overset{\text{Yards.}}{160}, \textit{ i.e. } 5\times 160=8\times 100,$$

and the proof is, that the product of the extremes is equal to the product of the means—viz. 800.

The only difficulty in solving questions by the rule of three consists in placing the numbers contained in the question in the proper order of their proportion. This depends upon a correct understanding of the conditions stated. The process of reasoning is, however, very simple. (1) Ascertain, from the nature of the question, that the solution depends upon a proportion. This is the case when it has (a) two terms of the same kind, which may be either multiplied or divided by the same number without making any change in the nature of the problem; and (b) a third quantity, which is of the same kind as the answer sought. (2) Next consider whether the answer ought to be a greater or less quantity than the odd term; that is, whether the unknown term which is to be found ought to be greater or less than the one of the same sort which is given. From this we determine which of the two given terms of the same kind ought to be placed first in the proportion—the least being placed first, as the divisor, when the answer ought to be greater than its corresponding term; and *vice versâ*. For example, in the preceding question, having set down 100 yards : x yards, we see that 8 men must, of course, do more work than 5 men, consequently x must be greater than 100; and hence, of the two numbers, 8 and 5, the last must be placed first. The following two questions will serve further to illustrate this rule:—

(1) A piece of work can be done in 5 days by 57 men: in how many days ought the same to be completed by 19 men?

This is plainly a question of proportion, since we might take two or three times as many days, and as many times fewer workmen, without any change in the problem. Again, our odd term is 5 days, and the answer sought is x days; and since a greater number of days must obviously be allowed to 19 men than to 57 men to accomplish the same amount of work, it follows that x is greater than 5; and consequently, of the two numbers, 19 and 57, the former is the first term of the proportion. The statement is therefore as follows:—

$$\overset{\text{Men.}}{19} : \overset{\text{Men.}}{57} :: \overset{\text{Days.}}{5} : \overset{\text{Days.}}{x}=\frac{5\times 57}{19}=15.$$

(2) Six yards of cloth, $\frac{3}{4}$ wide, were required for a certain purpose; how many yards would be necessary, the width being $\frac{2}{3}$?

Although in this question the four terms are all yards, we see that in one case they represent length and in the other breadth; and that 6 yards and the unknown quantity are of the same kind—namely, length. The second pair of terms of the proportion is therefore 6 yards : x yards. The broader the cloth the less the length necessary; and $\frac{3}{4}$ being greater than $\frac{2}{3}$, we must find x greater than 6. Consequently, $\frac{2}{3}$ will be the first and $\frac{3}{4}$ the second term of the proportion; *i.e.* $\frac{2}{3} : \frac{3}{4} :: 6 : x$. But as the first ratio will not be changed by multiplying its terms by the same number, we may get rid of the fractional form in which these terms are expressed, by multiplying them by any multiple of their denominators; that is, by 3×4, or 12. This multiplication being performed the proportion becomes

$$8 : 9 :: 6 : x, \text{ when } x=\frac{9\times 6}{8}=6\tfrac{3}{4};$$

i.e. $6\frac{3}{4}$ yards of cloth of $\frac{2}{3}$ yard wide are equivalent to 6 yards of $\frac{3}{4}$ yard wide.

EXERCISES.

Work out similarly the following questions:—

1. If a man by labouring 10 hours a day can in 9 days perform a certain piece of work, how many days would it require to do the same work were he to labour 15 hours a day? *Ans.* 6 days.

2. If a man by labouring 15 hours a day in 6 days can perform a certain piece of work, how many days would it require to do the same work by labouring 10 hours a day? *Ans.* 9 days.

3. If a man by labouring 10 hours a day can in 9 days perform a certain piece of work, how many hours must he labour each day to perform the same work in 6 days? *Ans.* 15 hours.

4. If 6 sheep are worth £18, what are 24 worth? *Ans.* £72.

5. If 20 men can till a field in 15 days, how many would be required to do it in 3 days? *Ans.* 100 men.

6. If a pole 7 feet long cast a shadow of 5 feet, how tall is a church spire whose shadow is 97 feet. *Ans.* $135\frac{4}{5}$ feet.

It often happens, especially in commercial questions, that the terms given consist of various denominations. This renders the calculation more lengthy, but it in no way affects the principle. Thus, suppose we have this question:—

What is the price of 18 yds. 2 qrs. 2 nails of cloth at the rate of 3 yds. 2 qrs. for £1 16*s.*?

Here the term sought is money, the corresponding term being £1 16*s.*; and since 18 yds. 2 qrs. 2 nails will cost more than 3 yds. 2 qrs., we make the least of these quantities the first term. The statement is therefore this:—

3 yds. 2 qrs. : 18 yds. 2 qrs. 2 nls. : : £1 16*s.* : £x.

But we cannot multiply and divide by the first terms in their compound state, and as they admit of multiplication without affecting the question, we reduce them both to the same denomination—namely, nails. We also reduce the third term to the lowest name contained in it—namely, shillings. The statement, thus practically modified, is as follows:—

56 nails : 298 nails : : 36 shillings : x shillings.

We might now proceed to multiply 36 shillings by 298, and to divide the product by 56; by which we would find the value of $x=191\frac{32}{56}$ shillings. But observing that the first and second terms are both divisible by 2, we may perform that operation, which does not affect the ratio. The statement is then reduced to the following:—

28 nails : 149 nails : : 36 shillings : x shillings.

We might solve the question also with these numbers, from which we would find $x=191\frac{16}{28}$ shillings as before; but since the first term is a divisor and the third a multiplier, it will evidently not affect the value of x—that is, the answer sought—to divide these terms by 4, and this done the proportion is as follows:—

7 nails : 149 nails : : 9 shillings : x shillings.

This is not susceptible of further reduction without fractions. To find x then we have

$$x \text{ shillings}=\frac{9 \text{ shillings}\times 149}{7}=191\tfrac{4}{7}\text{ shillings}=£9\ 11s.\ 6\tfrac{3}{4}d.\ \tfrac{3}{7}.$$

The compound quantities in this question might have been converted into fractions, and the operations performed by the rules for multiplying and dividing factions, thus—

$$\overset{\text{Yards.}}{3\tfrac{1}{2}=\tfrac{7}{2}} : \overset{\text{Yards.}}{18\tfrac{5}{8}=\tfrac{149}{8}} :: £1\tfrac{4}{5}=£\tfrac{9}{5} : £x,$$

$$\text{whence } x=£\frac{9\times 149\times 2}{7\times 8\times 5}=\frac{2682}{280}=£9\ 11s.\ 6\tfrac{3}{4}d.\ \tfrac{3}{7}.$$

Or, once more, the quantities might be converted into decimals, and the operations performed by the rules for decimals; as,

$$3{\cdot}5 \text{ yds.} : 18{\cdot}625 \text{ yds.} :: £1{\cdot}8 : £x,$$

and, dividing the first two terms by 5, this becomes

$$\cdot 7 \text{ yds.} : 3{\cdot}725 \text{ yds.} :: £1{\cdot}8 : £x,$$

$$\text{whence } x = £\frac{1{\cdot}8 \times 3{\cdot}725}{\cdot 7} = £\frac{6{\cdot}705}{\cdot 7} = £9\ 11s.\ 6\tfrac{3}{4}d.\ {\cdot}102857.$$

From the preceding examples it appears then (1) that the first and second terms must be of the same kind and denomination, (2) that the third term may be reduced to any denomination which may be the most convenient, and (3) that the answer will be a quantity of the same name. The first and second terms, and also the first and third terms, may be multiplied or divided by any number without affecting the answer—which allows of the terms being reduced, and the operation abridged or made more convenient. No precise rule, however, can be given for the performance of these modifications; and it depends entirely upon the ingenuity of the student to detect when they are applicable, and to what extent.

An examination of the following examples will show the consideration usually involved in stating the question:—

1. If a man travel 243 miles in 9 days, how far will he travel in 24 days? *Ans.* 648 miles.

As the answer to the question must be in miles, we make the third term miles (243); and from the nature of the question we know that he will travel further in 24 days than in 9; we therefore place 24, as the larger of the two remaining terms, in the second place, and the remaining number, 9 days, in the first place.

```
days. days. miles.
 9  :  24  :: 243
               24
             ----
              972
             486
             ----
          9)5832
             ----
        Ans. 648 miles.
```

2. How many yards of calico, 5 quarters wide, will line 20 yards of cotton that is 3 quarters wide?

```
qrs.     qrs.      yards.
 5    :   3    ::   20
                     3
                    --
                  5)60
                    --
              Ans. 12 yards.
```

Or by cancelling:—

```
5 : 3 :: 20=1 · 3 :: 4
                     3
                    --
                    12
```

3. How many yards of carpeting, half a yard wide, will cover a floor 30 feet long and 18 wide? *Ans.* 120 yards.

4. If a man perform a journey in 15 days when the day is 12 hours long, in how many days will he do it when the day is but 10 hours long? *Ans.* 18 days.

5. If 450 men are in a garrison, and their provisions will last them but 5 months, how many must leave the garrison that the same provisions may be sufficient for those who remain 9 months? *Ans.* 200 men.

6. If a regiment of soldiers consisting of 1000 men were to be clothed, each suit containing $3\frac{3}{4}$ yards of cloth $1\frac{7}{8}$ yards wide and to be lined with flannel $1\frac{1}{4}$ yards wide, how many yards will it take to line the whole? *Ans.* 5625 yards.

In some treatises on arithmetic the student will find what are called *direct* and *inverse* rules-of-three, with examples and exercises. Any such distinction is futile. Should he understand the subject thoroughly, as explained in this chapter, he will find little difficulty in solving any rule-of-three question which may come before him, whether the numbers are simple or compound, or the proportions are direct or indirect.

THE LATIN LANGUAGE.—CHAPTER XV.

SYNTAX OF THE SUBJUNCTIVE MOOD—OBLIQUA ORATIO—CLASSICAL STUDY—OUTLINE OF THE HISTORY OF LATIN LITERATURE.

On two points of considerable difficulty and importance in the methodical syntax of Latin speech we require yet to supply some explanations and directions—(1) the use of the subjunctive mood, and (2) the form in which the Romans indicated that statements made by others are being repeated, reported, or referred to by a person who is speaking or writing.

Two moods alone possess a complete apparatus of personal terminations sufficient in every case to make a clear distinction between certainties and contingencies. Of these the indicative must always be used in the direct and definite statement of matters of fact [*i.e.* of those concerning which no elements of contingency enter our thoughts]; but when any element of contingency in regard to matters of fact, feeling, or circumstance is distinctly present to the mind the subjunctive must be used. If men were always logical and self-consistent in their thoughts, this principle would be sufficient to guide us through the greater part at least of the intricacies of those specific usages in syntax about which scholastic polemics have been voluminously employed, and we should have little need for the unnecessarily numerous rules—involving not only many exceptions, but exceptions to these in perplexing variety—which grammarians give us rather to remember than to think about. But this is not the case; logic does not always rule, and rhetoric sometimes intervenes. For instance, the celebrated orator Cicero uses *Tempus fuit quum homines vagabantur*, while his learned contemporary Varro, in a sentence precisely similar as an assertive statement, says, *Tempus fuit quum homines rura colerent.*

In "Phædrus" we find *Quidnam voluisti tibi, infelix, ultro qui ad necem cucurreris?* where the last word, which is in the subjunctive, really bears no other signification than the indicative *cucurristi;* and Cicero in "De Finibus," with dexterous delicacy, says, *Quod quum accidisset, ut alter alterum videremus*, &c., though the sense intended to be conveyed was *videbamus.* There is a borderland—if we may so designate it—of experience, which, though not absolutely invariable, is so generally accepted as uniform and of inference so nearly certain to be right that the indicative may be used in reference to it; and there are circumstances in which it would be harsh, dogmatic, offensive, or inexpedient to make decisive statements as matters of facts, and in such cases the subjunctive may be employed where an indicative would have been admissible. Such cases really belong to the metaphysics of expression, and no mere syntactic rules can guide the student in the use or the avoidance of them; he must get at the principle which underlies the rules.

Because as a general rule the indicative usually appears in direct, independent, and principal clauses, and the subjunctive in indirect, dependent, and subordinate clauses, a name has been given to the latter which expresses the general fact regarding it—viz. that it is usually subjoined to other verbs and placed after certain particles and phrases which are sometimes said to govern or require it. In this usage the subjunctive mood helps very much to enable us to discriminate the dependent clauses of a compound sentence from the chief clause on which they depend, and this in the long and elaborated periods of the Latin writers is a great convenience.

The tenses of the Latin subjunctive are generally characterized by the insertion of *i* in the personal terminations, and their ordinary purpose is to show that some sort of uncertainty rests upon the matter which is spoken of; as, *Natura declarat* (indic.), *quid velit* (subj.)

The subjunctive mood has two general uses—(1) Independent or pure—*i.e.* not subordinate to another verb, but requiring that form for the *expression* of its sense; (2) dependent or subjunctive—*i.e.* subordinate to another verb, and put in that form to *indicate* its [subjunctive] relation.

The subjunctive mood is pure when it occurs in the predication of a principal sentence. Its pure uses are various, viz.:

(1) Potential; as, *Ita amicos pares*, Thus you may get friends; *Dixerit aliquis*, Some one may say.

(2) Conditional; as, *Velim tecum esse*, I should wish to be with you; *Crederes victos*, You would have supposed them vanquished.

(3) Concessive; as, *Age dicat*, Well, he may speak; *Fuerit sapiens*, Were he wise.

(4) Optative; as, *Valeant cives mei*, May my countrymen flourish!

(5) Doubting; as, *Faveas tu hosti?* Must you favour a foe?

(6) Inquiring (indirectly); as, *Quid faciam?* What am I to do?

(7) Exhortative; as, *Imitemur bonos*, Let us imitate the good; *Rem tuam curares*, You should have been attending to your own business.

The independent subjunctive requires, when translated into English, auxiliary verbs to convey its meaning, such as *shall, will; would, should; can, could; may, might*; as,

Amem te [si bonus sis],	*I can love you [if you are good].*
Amarem te [si bonus esses],	*I should [could* or *would] love you [if you were good]*, or *I should* [&c.] *have been loving you [if you were good].*
Amavissem te [si bonus fuisses or esses],	*I should* [&c.] *have loved you [if you had been good].*

The dependent subjunctive has sometimes a sign in English; as, *Ede ut vivas*, Eat that you may live; but it must often be translated as if it were indicative; as, *Laudatur quod paruerit*, He is praised because he obeyed—*Laudavi eum qui paruisset*, I praised him [as one] who had obeyed.

One subjunctive mood has often other subjunctives in subordination to it; as, *Clamant omnes: præstaret quod recepisset*, All cry out [that] he should perform what he had undertaken.

These logically different cases are not distinguished in Latin by differing grammatical forms. The context, or our previous knowledge, must determine whether the case is contemplated as possible [*i.e.* entirely within our own or some other person's power] or not, unless some previous condition has been conceded. In Latin we may require to express (1) simple certainty or uncertainty, or (2) simple futurity (generally implying some sort of uncertainty), or (3) uncertainty and futurity both combined, with an indication, it may be, of the conviction entertained by the speaker of the amount of certainty or uncertainty he feels or acknowledges. Thus there arise four sub-cases, viz.:—

1. Possibility, or simple supposition, without any note of uncertainty, expressed by the indicative in both clauses; as, *Si quid habet, dat*, If he has anything, he gives it.

2. Uncertainty with the prospect of decision, expressed by *si* with the subjunctive present [or perfect]; and the indicative, commonly the future [sometimes the imperative], in the consequence; as, *Si quid habeat, dabit*, If he has [=may have] anything, he will give it.

3. Uncertainty without any such accessory notion as the prospect of decision, given expression to by the imperfect subjunctive clauses; as, *Si quid haberet, daret*, If he should have [or were to have] anything, he would give it.

4. Impossibility, or belief that the thing is not so, in which we make use of the subjunctive in both clauses, (1) the imperfect for present time, and a continuing consequence, (2) the pluperfect for past time; as, (1) *Si quid haberet, daret*, If he had anything, he would give it; (2) *Si quid habuisset, dedisset*, If he had had anything, he would have given it.

Such relative clauses as simply explain some word or circumstance contained in a principal clause take the verb in the indicative; as, *Miles qui interfectus est centurio fuit*, The soldier who was slain was a centurion. But when a clause introduced by a relative implies at the same time, besides a simple explanation, any idea of intention, condition, result, consequence, cause, &c., the subjunctive is employed. In all these cases the relative involves the idea of *ut* (in order that, so that), *quum* (as, since), or *si* (if); as, *Legatos misit qui pacem peterent*, He sent ambassadors who [*i.e.* in order that they] might sue for peace; *Zenonem, quum Athenas essem, audiebam*, When [as, while] I was at Athens I heard Zeno; *Librum si habeam, mittam*, If I have the book I shall send it; *Deus fecit aves quæ volitant in aëre et pisces qui natant in aquis*, God made the birds which fly in the air and the fish which swim in the waters. *Quæ volitarent* would mean that He created the birds in order that they might fly [*i.e.* for the purpose of flying]. So with *qui natarent*.

The different classes of secondary sentences are most easily distinguished practically, perhaps, by the conjunctions or pronouns which join them to the principal clause.

(1) Secondary sentences commencing with the following conjunctions or adverbial conjunctions take the verb in the indicative:—*An, ne, num* (when interrogative); *ceu*, as; *donec*, as long as; *dum*, whilst; *etsi*, although; *perinde*, as; *postquam, posteaquam*, after; *quasi*, as; *quando*, when, since; *quandoquidem, quoniam*, since; *quanquam*, although; *quin*, why not? *quippe*, for; *tametsi*, although; *tanquam*, as; *ut*, as, how, since, when.

(2) Such secondary sentences as begin with the following conjunctions take the verb in the subjunctive:—*An, ne, num*, (when expressing doubt); *ceu*, as if; *cum*, since, although; *dum, dummodo*, provided; *etiamsi*, although; *licet*, although; *modo*, provided; *ne*, lest; *perinde ac si*, as if; *quamvis*, although; *quasi*, as if; *quin*, but that; *quippe que*, as he; *quo*, that; *quoad*, until; *si*, although; *tanquam*, as if; *ut*, that, although; *utinam*, I wish; *utpote cum*, seeing that.

(3) Subordinate sentences commencing with the following conjunctions may have the verb either in the indicative or subjunctive:—*Antequam*, before; *donec, dum*, until; *priusquam*, before; *quia, quod*, because; *quoad*, as long as, as far as; *simul, simul ac, simul atque, simul ut*, as soon as; *ubi*, when.

(4) Sentences beginning with the following, before the imperfect and pluperfect, govern the subjunctive; but before the other tenses, generally the indicative:—*Cum*, when; *ni, nisi*, unless; *siquidem, si*, if; *sin*, but if.

A conjunction is not unfrequently understood; as *Philosophiæ servias oportet*, It is right (*ut*, that you) be a servant to philosophy; *Quæram justum sit necne poema*, I will inquire (*utrum*, whether) it be a true poem or not; *Partem opere in tanto, sineret dolor, Icare, haberes*, O Icarus, thou wouldst have a share in this great work (*si*, if) grief would permit.

In the common language of grammarians those moods are said to be governed by these conjunctions. This, however, only means that such conjunctions are used, always or in certain senses, with certain moods. The mood as a form of thought is independent of conjunctions; but they enable us to distinguish the relations of clauses more clearly, just as prepositions aid us in distinguishing the relations of nouns.

It often happens that we require not only to relate our own experience, and to state our own views, but to recount, indicate, or epitomize what we have learned from others, or the opinions which they have expressed. Such reports we may present either in (1) a direct historic and dramatic form, reproducing the very words uttered, or (2) in an indirect manner, giving the gist of what was said, throwing the speaker's matter into a fresh shape—not showing the person uttering his own words himself, but giving them utterance in the reporter's form and words; as, (1) *Pœnas ego de iis sumam qui meas vites inciderunt*, I will avenge myself on those who have cut down my vines; (2) *Exclamavit pœnas se de iis sumpturum esse qui suas vites incidissent*, He cried out that he would avenge himself on those who had cut down his vines.

Such secondary sentences as contain not the direct expression [*i.e.* the precise words] of a speaker, but a report of that by some other person who quotes it, is called indirect speech (*oratio obliqua*): *e.g. Aqua est rerum initium*, is a direct statement [*i.e. oratio recta*]; *Thales aquam dixit esse rerum initium*, is an indirect statement [*oratio obliqua*].

If the indicative is employed in an indirect speech, it shows that the clause in which it occurs is the speaker's own sentiment, not that of the person whose speech he is reporting; *e.g. Aristides ob eam causam expulsus est patria, quod præter modum justus erat*, assigns the speaker's explanation of the banishment of Aristides; *esset* would supply the reason assigned by his enemies for it.

Diogenes contemnebat divitias quæ se felicem reddere non possent, signifies Diogenes despised riches [inasmuch as they] could not make him happy. This form of narrative indicates that the reason stated was that felt by Diogenes. *Quæ eum felicem reddere non poterant*, would have indicated that the reporter interpreted that to be the reason for Diogenes' contempt.

In sentences containing indirect speech, therefore, the predicate is put in the subjunctive; as, *Athenienses Socratem capitis condemnaverunt, quod juventutem corrumperet*, The

Athenians condemned Socrates to death because (in their opinion) he corrupted youth.

The *oratio obliqua* may be distinguished from *oratio recta* by the following differences of construction: (1) indicatives in principal clauses become infinitives, and in subordinate clauses subjunctives; (2) imperatives are changed into infinitives; (3) present tenses are turned into perfects (and all related words are suitably altered); (4) pronouns of the first and second persons become third persons; and (5) the pronouns *ego*, *nos*, *meus*, *noster*—referring to the person (or persons) whose words are indirectly given—become *sui*, *ipse* (or *ipsi*), and *suus*.

Latin grammarians very often employ the words *oratio obliqua* in two different meanings—(1) When the writer expresses, not his own thoughts, but the thoughts of another; as, *Ariovistus respondit non oportere se in suo jure impediri*, Ariovistus answered that he must not be thwarted in the exercise of his right; *Veneti legationem ad P. Crassum mittunt, " Si velit suos recipere, obsides sibi remittat,"* The Veneti send ambassadors to P. Crassus, saying, " If he wishes to receive back his own (hostages), let him send their hostages back to them;" (2) when he expresses his own thoughts but subjoins them as an accusative to a verb; as, *Rex militibus suis dixit, Barbaras contra quos eos illo die duceret imperio suo diu restitisse: Fortiter pugnasset et se habere eos fore victores*, The king said to his soldiers, that the barbarians against whom he was that day leading them had long resisted his authority: Let them fight bravely and he was confident they would be victorious.

Instances of indirect narration may extend from a single clause in a sentence to a chapter, and even many chapters. At times, that a writer may rhetorically show the increasing intensity of a speaker's emotion as he proceeds, a transition is made from the indirect to the direct form, and that, too, without any intimation. The converse very seldom occurs.

In regard to these two difficult points—and indeed all the specialties of Latin construction—thoughtful and observant reading is the best interpreter of both rules and reasons. Every student ought carefully to note the syntactic form of each clause and sentence, and endeavour to understand the interrelations of each to the other. It may be that the reason may not suggest itself just at the moment, but the habit of thinking will be found of incalculable advantage, and industrious reflective study will at length result in unexpected success and gratification.

The acquisition of such thorough thoughtfulness is one of the main advantages derivable from classical studies. They supply the means of exciting a disciplinal development of intellectual faculty. The mere advantage of becoming acquainted with the original etymological forms of three-tenths of the words in use in our own tongue—and these mainly the technical terms of the arts and sciences, and those words which form the chief part of the special vocabulary of the best thinkers—is undoubtedly great. So is the other gift which the study of Latin places in the hands of a student—namely, a key to the lexicons of the widely diffused Romanic languages, Italian, Spanish, Portuguese, French, &c.—so that he may with much ease and readiness acquire these important tongues, besides knowing in their radical forms a large proportion of the modern adoptions and additions of the spoken languages of the world, most of which are derived from classical sources. But not even these are to be compared with the culture induced by the study of a specific speech possessed of an articulate organization, in the course of which we learn how a language is built up from the skeleton-forms of the paradigms to the ornate orations which Cicero delivered in the forum and the senate, the brilliant lights and shadows which give grace to Livy's pictured page, the strong, swift onsweep of the Commentaries of Cæsar, the lambent yet lurid rainbow-like reflections of Lucretius, the fascinating humour of Horace, and the lustrous labyrinths of the Virgilian epic. How the structure develops from those early rudimentary elements to that vast and beautifully adorned literature into which the

> " Fabric of thought
> Is like a web by cunning master wrought!"

The student who looks upon his learning of Latin as a hard, dry, mechanical, precise piece of taskwork only, in which he finds himself hemmed in and hampered by complicated inflexion-forms and definite syntactic rules, must try to turn his mind to the wonderful products in the formation of which these have aided, and into which they have been interwrought. As the finest drawings and the most marvellous paintings are but the realized results of skilfully arranged and composed lines, so the most splendid masterpieces of literature are thoughts represented by words intertessellated and articulated in accordance with paradigm and rule.

It is not very easy amid the *débris* of destruction to trace out, gather up, and put together, the fragments of a Venus—as was done at Tivoli with the masterpiece of Cleomenes—into the fullness and form of the original. Even when some immense palace of industry or art is to be built, an observant eye and an active intellect are required to realize how, out of the bricks and stones, spandrils and beams, bolts and screws, and all the various parts prepared, there is to arise thence a mighty edifice—transfiguring and harmonizing all the *disjecta membra* of the artificers into grandeur and beauty. In the same way it is not to be expected that the student, while engaged in the drill and grind of accidence and syntax—learning the inward mechanism of vocables, and the scaffolding of sentences—can comprehend all the conditions of that important practical problem which is involved in the upbuilding of such magnificent intellectual designs as have been reared by Terence, Ovid, Juvenal, Tacitus, and many others already mentioned as holding high place among

> " Men whom we build our love round like an arch
> Of triumph."

But the intelligent and appreciative mind will readily perceive that the duty of apprenticeship—useless as it may appear, and troublesome though it may be—is requisite in order that the trustworthy skill of the master may be acquired, and that training is the preparative for achievement. Such a one shall betake himself to his task, not as something servile or menial, but as a gymnastic exercise likely to increase power and invigorate cultured energy of intellect. Without despising the possible minor utilities of learning a new language, he will delight to find a permanent habit of rigorous though almost unconscious reasoning growing within him while investigating the meaning of words and reflectively defining the thoughts they express. Even the few lexilogical tasks to which we have led the student must have aided him to feel the efficiency of the discipline they yield in lucid arrangement, in the sense of the fitness of part and whole, and in the acquirement of the stimulating feeling which arises from being able to observe the inner workings of the mind impressed on and expressed by an articulately organized language.

Nearly five centuries elapsed before the language of the Pelasgic races was prepared for becoming a fit literary instrument. Livius Andronicus, a Greek freedman, was the first dramatist of Rome (514 A.U.C.), and Ennius (died 545 A.U.C.) was the originator of satire. The "laughter, sport, and jest" which Plautus (500–69 A.U.C.) provided in his comedies may yet be enjoyed; Pacuvius and Attius early won the highest favours of the tragic muse; Gregory I. destroyed the plays of Afranius, but we have still extant some of the comedies of Publius Terence, who was patronized by Scipio Africanus, and died, aged thirty-four, in 594 A.U.C. The poet Archias dwelt with the lordly Lucullus. Cato the Censor (died 604 A.U.C.), in his youth wrote a "Treatise on Agriculture," and subsequently attained repute as a historian. Between the period when Sulla the dictator died and the fall of the republic by the murder of Cæsar, the lofty philosophical poem of Lucretius, winged with enthusiasm, went forth into favour. In lyric, elegiac, and epigrammatic poetry Caius Valerius Catullus excelled, and his management of the hexameter is exceedingly happy. The concise but rather elaborate histories of Sallust, and Cæsar's Commentaries—soldierly, brisk, extemporaneous-like, though carefully suited to his purpose—as well as many other works from the same pen, illustrate the second period, to which also belong the antiquarian works of the most

learned of the Romans, Marcus Terentius Varro, and the voluminous epistles, the varied, ingenious, though often declamatory orations, the valuable and highly finished philosophical treatises, and the eloquent, well-arranged, and exhaustive rhetorical works of Cicero. The Augustan age was adorned by the copiousness and versatility of Virgil, the gracious good sense and humour of Horace, the quiet refinement and lovelorn tenderness of Tibullus, the more learned but equally amatory Propertius, and the most vivid, brilliant, melodious, and original of Roman poets, Publius Ovidius Naso—unfortunate in life, favoured by fame. Besides these we must note the most popular of Roman historians, Livy, whose beauty of style has been the admiration of ages, though Arnold doubts his fullness and accuracy. With the death of Augustus (14 A.D.) decay set in, and we have little more to record for 160 years than the crisp, clear, sensible, and animated history of Tacitus, the somewhat ponderous philosophy of Seneca, the writings of the elder and the younger Pliny, and the vigorous but rather uncleanly productions of Appuleius, in prose; and in poetry the naughty epigrams of Martial, the rather rhetorical "Pharsalia" and other works of Lucan, the rural poetry of Columella, and the scathing fierceness of the Satires of Juvenal. Poetry under the Vespasians, though Titus himself was a poet, did not flourish, yet the (unfinished) "Argonautica" of Caius Valerius Flaccus contains some fair imaginative turns, and the "Punica" of Silius Italicus is not destitute of merit and elegance. From the death of Marcus Aurelius—whose "Meditationes" are a very remarkable product of pagan philosophy—Latin literature had little prosperity. Lucian's playful originality and sarcastic humour were engaged not in the investigation, but the derision of Christian faith. The Alexandria-born Claudius Claudianus was a genuine poet in the midst of a horde of mere versifiers. Annalists and chroniclers took the place of historians, and though Lactantius, under Constantine, almost restored in his "Phœnix" the fine form of verse used in the Augustan time, under Theodoric, "the last of the Goths," the light of Latin literature may be said to have expired in the growing gloom of the dark ages. Symmachus—against whom Prudentius issued his "Contra Symmachum"—wrote epistles modelled on those of Pliny and the classic writers. The historical, grammatical, and theological works of Cassiodorus show the decline of Latin prose composition, though his "Letters" exhibit taste, tact, and talent. The "De Consolatione Philosophiæ" of Bœthius is the masterpiece of the last, and by no means the least, of the men of genius who may be said to have belonged to the literary men of ancient Rome. It is full of fine philosophic reflection, and is in style much superior to the writings of his age; but though written while in prison awaiting execution (A.D. 525), it does not name "Christus Consolator."

The concise and rapid survey here given may encourage those who have followed our course of lessons in Latin to press onwards in their endeavour to possess a knowledge of that language which for a thousand years was spoken throughout the territories of the mistress of the world, and is yet through all the regions of civilization the most efficient agent in the disciplinary culture of all professional men and all aspiring minds.

PHYSIOLOGY.—CHAPTER XV.

HYGIENE—SANITARY LAW—DISEASES AND THEIR CLASSIFICATION—THE WONDER OF HUMAN LIFE.

The application of the teachings of physiology to home, social, civic, and national life is of very great importance. This was made remarkably clear to the general public by the issue of what might almost be called a romance of physiology by Dr. B. W. Richardson, under the title of "Hygieia," in which he explained the ideal of a city properly constructed in every point, with "all appliances and means to boot" for a hygienic and sanitary residence, in which every agency detrimental to health had its power and activity minimized, and every requirement for the protection of life was provided for up to the maximum. But we mostly live in old cities, and in places where the influences of our forefathers prevail, and we are not likely soon to have the privilege of beginning the work of civilization entirely *de novo* in such a way as—by choice of site, soil, climate, surroundings, and by the use of the most advanced and improved mode of construction, from drainage to roofing—to secure the opportunity of righting all the wrongs which have arisen in the development of residential cities. Most of us must do the best we can with things as they are, and use our knowledge, if possible, to guide us in bettering what we have, rather than in sighing for the unattainable. As to a *home*, the best practical advice a physiologist could give is perhaps this:—Whether you rent or purchase do so deliberately, after full inquiry and examination, and above all take the best house your means can afford—in its construction, accommodation, position, surroundings, and adaptation to your personal and family circumstances and mode of life. It should be in as free and open a position as can be got; as far from any insanitary influence as possible, such as chemical works, slaughter-houses, stagnant water, dust-heaps, or drain-openings; with abundance of sunlight playing on and around it, large and numerous windows, easily cleaned, and no need for using artificial light during the day—but with the most direct light reaching the rooms to be most used by the inmates. The home should possess full accommodation for house-work, family intercourse, recreation, and rest, as well as possibility of comfortable nursing, and, if necessary, isolation in case of sickness. As to *air*—it should be seen (1) that a supply requisite for the full performance of respiration (*i.e.* about 3000 cubic feet per hour per head) is available in every part of it; (2) that the entering air is pure (*i.e.* free from organic, inorganic, gaseous, or other avoidable suspended matter) and not unnecessarily damp or cold; and (3) that the means of ventilation (*i.e.* the means of purifying the air contaminated by use) are ample, effective, and safe—affording circulation without draughts In regard to *water*—(1) it should be made certain that the daily quantity available should be sufficient, (*a*) for personal consumption in drinking and cookery; (*b*) for domestic use in cleansing person, clothing, habitation, and immediate surroundings; and (*c*) for sewerage—the effective carrying away of all refuse, filth, or effete matter; (2) the source, characteristics, storage, and mode of conveyance of the water should be examined and known, as an insufficient and impure supply of water is highly insanitary, and its consequences are little less deteriorating morally than they are deleterious physically; (3) the mode of disposing of used water by drainage-sewers ought to be looked to, that it has a free and immediate outlet, and that regurgitation either of water or of drain-gases is carefully guarded against. In regard to *site*—we should see that it is dry, free from malaria, and secure of a due circulation of fresh and healthy air. Low, humid, and cold-soiled sites are specially to be avoided, as well as houses on sites inclosed by high buildings, walls, or public works, and those near graveyards, pools, canals, water-courses, or sewers near the surface. In reference to construction, no house can advisably be taken in which the living-rooms are under the ground-level (even on one side); of which the foundations, the walls, and the roof are not distinctly free from the inlet of damp; and the rooms of which are not cheerful, bright, and free from smoke when fires are lit. Houses in densely packed, crowded, narrow streets, or those closed up at one end by wall or building, are not desirable as dwellings.

When a well-chosen house has been taken and inhabited careful attention must be given to the free entrance of sunlight—which is really energy, force, power. It promotes chemical and vital changes, stimulates the nervous system, oxidizes decaying matter, and destroys the virulent properties of it. The healthy activity of all the functions, as they develop, is increased by light. Light quickens and heightens the general vitality, darkness favours uncleanness and corruption. Let all windows be clean and bright, and do not let dark wall-papers be used to hide dirt, or allow the corners of rooms to be unlighted that carelessness as to cleanliness may be concealed. Plenty of sunlight means joy and health, only do not live in and look at the full glare of it. In the use of artificial light, remember that it arises from carbon being rapidly oxidized, and that it affects the healthiness of the air. Watch, therefore, the pressure of gas and the character of the flame it yields, and never avoidably let it be unsteady.

smoky, or kept ablaze in an unventilated room. Next see to the ventilation being kept thorough and constant, yet not such as to produce draughts. Exposure to cold—especially damp cold—arising from sudden variations of temperature in the air is provocative of bronchial, pulmonary, and rheumatic ailments. Defective ventilation allows noxious materials—dust particles, chemical poisons, contaminations from the body, the germs or septic particles of malarious, contagious, or infectious diseases—to accumulate, and makes healthy breathing impossible. Regulate especially the ventilation of bedrooms, and never heat them with gas; for in them we spend, often incapable of knowing the evil we suffer from, nearly a third of our days. A nasty fœtid smell anywhere, but especially in a bedroom, is a danger-signal. Immediately look to it that pure air is provided slowly yet plentifully. No animal can live healthily unless constantly supplied with pure air. Heating also requires attention. It is a prime condition of health that the temperature of the body should be kept at a fixed normal point—98° to 99° Fahr., irrespective of the variable state of the surrounding air. The production of heat is a result of the chemical changes regularly occurring in all the tissues, but particularly in the great glandular organs, *e.g.* the liver. The loss of heat is due to radiation and evaporation by skin and lungs. To keep up the balance of heat-products and heat-losses we use fuel, clothes, food, &c. Heat should be generally diffused through a house so as keep the whole air at a uniform, agreeable, healthy temperature. The water—supply and removal—cisterns, pipes, drains, &c., demand constant attention to prevent filth, leakage, and damage. Regular, careful, stated cleansing of floors, walls, ceilings, furniture, passages, cellarages, stairs, clothes, carpets, hangings, &c., must also be attended to if the home-life is to be healthy and comfortable. The power and habit of self-control, leading to diligence, order, and regularity, will concur in securing a due attention to the laws of physiology in the home.

The law of the physiology of social life is that it is the duty of each member of a social confederacy—neighbours, co-proprietors, &c.—to avoid doing anything, habitually or occasionally, which either does or may seriously interfere with the comfort, injure the health, or endanger the life of those around him. He will therefore do all in his power, by attention to sanitary requirements, to protect his own health and the health of others, and use all diligence in observing those means by which the causes of sickness may be diminished, and the general welfare of himself and others promoted. Each one ought therefore, as far as possible, to avoid doing anything which may (1) injure the air we breathe or the water we drink, by loading either with noxious impurities, or (2) prevent the free circulation and use of both; and should discountenance and discourage all acts and habits against personal and general health. This may be specially done by the observance of sanitary regulations regarding cleanliness; by securing the thorough isolation of the sick, and the use of disinfectants in all places and on all materials requiring it; by employing every means we can (1) to prevent the spread of infectious diseases, and (2) to make ourselves or others, as far as possible, insusceptible of attack by them; in short, by carrying out, as far as our knowledge goes and our ability extends, in our own houses, premises, precincts, and neighbourhoods, every arrangement for improving and perfecting sanitation—more especially, in times of the prevalence of any epidemic, taking care that every precaution be used to preserve our own and our family's health in the best possible condition.

Civic sanitation is provided for at once by common and by statute law. The very just principle of the law of nuisance runs that "no one is entitled to use his property so as (1) to cause injury to his neighbour's property or (2) to the health of his neighbour, or (3) to render the occupation of his neighbour's property positively uncomfortable." Statute law provides in most populous places for the safeguarding of public and private drains and sewers with efficient traps, coverings, or means of ventilation; and requires that no new house be erected without due drainage on some approved plan, and some means for the safe removal and disposal of waste matter. The owner of a house (or part of a house) occupied by a separate family must not only introduce water into it, but also keep the cisterns, sinks, soil-pipes, &c., in such condition that effluvium and leakage are prevented; and if a court, yard, or area belong to the house, it must be cleaned out three times a week. Owners of property having common stairs and passages must provide proper ventilation, and wash and paint the same at stated intervals. The respective tenants require to sweep and clean the landing-places and steps at least once a week. If a tenant allow filth to accumulate in a house the authorities may enter the house and cleanse it at the tenant's (or owner's) expense. In the case of private houses no precautions have been taken in regard to internal ventilation, but if a building is intended to hold a number of people, the supply of sufficient fresh air must be satisfactorily provided for, and the means of access and egress must be shown to be commodious and safe. The authorities are also empowered, in certain circumstances, to enforce cleanliness and the isolation of disease. These and a few other matters, such as the securing of the general cleansing of streets and the observance of the laws of sanitation included in the civic acts by which towns are governed, are the powers possessed by the authorities of inducing compliance with some of the more obvious requirements of physiology.

The application of sanitary science to the preservation of the public health has been in modern times—since, by the cessation of our great wars, an opportunity for attending to practical reforms has been found—brought effectively before society by Dr. Southwood Smith, Edwin Chadwick, and Dr. William Farr. The first, by his "Philosophy of Health" (1832), roused the country and the legislature to a sense of the immediate need of sanitary reform; the second advocated the duty of the legislator to become the framer of laws for the regulation and administration of the public health; the third brought an acute and earnest mind to the scientific calculation of the data of health, disease, and life. "The General Report on the Sanitary Condition of the Labouring Population of Great Britain," issued in 1842, is the true starting-point of modern sanitary legislation, and of the practical application of medical science to the preservation and improvement of the health of the community. The General Board of Public Health was instituted in 1848, and had committed to its charge the sanitary improvement of towns. Under several Acts it exerted a beneficial influence on public health until, in 1871, the Local Government Board was constituted for the supervision of the administration of sanitary laws. Since that time the sphere and operations of this board have been extended and its powers increased by many statutes, which place under its supervision and control almost all matters connected with the national health and the means by which it may be maintained and enhanced. Much good has been effected by moving corporate bodies in many unwholesome districts into taking active measures for the removal of unsanitary nuisances and the suppression of unhealthy modes of manufacture. It has helped to secure less adulterated food, a purer atmosphere, more wholesome surroundings, greater means of personal cleanliness, and reliable advice and information on the prevention of disease. This physical improvement has been accompanied, too, by other benefits: it has enabled many to resist and overcome the moral infection to which they have been exposed. This board, on the part of the nation, and in behalf of the health of the entire community, supplies (1) a responsible agency for the control, repression, or removal of such unsanitary conditions as the public at large have an interest in diminishing or getting rid of; (2) an arbitral authority for settling disputes between local interests, and so aiding in the economic and effective action of local and central administration for the general good; (3) an opportunity of appeal for the protection of minorities, absentees, &c., against wasteful works, improper or unduly distributed local charges, &c.; and (4) a centre whence information and direction may be communicated to different localities, founded upon principles deduced from a wide and thoughtful survey of the results of the experience of other places, in similar circumstances, pursuing like plans. At the same time, also, it forms a constantly available centre to which complaint can be conveyed regarding any local authority in default or negligent, and whence constitutional

enforcement of duty may be issued. These are, in one department of its work, the official purposes of this national central bureau, for the application of the principles of physiology to the promotion of the health and longevity of the population of the country. Among the other serviceable functions it performs is the collection of vital statistics—on the ebb and flow of mortality, the conditions and causes of prevalent diseases, or an abnormally increasing high death-rate, the effect of preventive measures, and the influence of social customs upon the increase or diminution of certain diseases, and so on. Many of the facts revealed by its inquiries are of great importance as well as somewhat curious; *e.g.* that the death-rate increases with the increasing density of the population, and *vice versâ*; that it is easier to keep out of a diseased state than to get out of it; that nearly one-ninth of the population have been, by sanitary appliances, kept out of a sick bed since the improvements pressed by hygienic law have been put in operation; that between a damp subsoil and consumption there is an association, and that drainage checks its progress; that asthmatic complaints, arising from breathing an atmosphere charged with fluff, floss, dye-dust, &c., prevails among drapers; that the death-rate of cabmen and publicans is nearly equal, and twice as high as that of clergymen, &c. The statistics of the phenomena of diseases are founded on a carefully classified system of the various diseases to which the human frame is liable, the nature of which is of considerable interest, and of which the following is an outline:—

In that department of physiological research whose office it is to classify diseases and to present them to the student's mind in an arranged system—which bears the name of Nosology (Gr. *nosos*, a disease)—the prevailing classification is fourfold, viz. (1) developmental, (2) constitutional, (3) local, and (4) zymotic. To the first class belong those special forms of ill-health which are incidental to the formative, nutritive, and reproductive processes, such as (1) malformations and deformities, idiocy, teething, breathing, digestion, &c., in the early periods, infantile and juvenile, of life; (2) the changes characteristic of development into manhood and womanhood; (3) those connected with the nutritive functions and interfering with their natural course; and (4) those which indicate and accompany decay of function arising from age. In the second class may be reckoned (1) diathetic tendency (Gr. *diathesis*, condition) to the deposition of morbid products—*e.g.* anemia, gout, cancer, lupus, melanosis; (2) tubercular ailments—*e.g.* phthisis, scrofula, mesenteric disease, and a form of meningitis. To the third class, which affect the function of special systems or organs, belong (1) *brain* (or rather nervous) diseases—epilepsy, chorea, hysteria, mania, paralysis, apoplexy; (2) *heart* (or circulatory) diseases—varicose veins, phlebitis, ætheroma, aneurism, endocarditis, pericarditis, angina pectoris; (3) *lung* (or respiratory)—laryngitis, empyema, asthma, pleurisy, pneumonia, bronchitis; (4) *bowel* (or digestive)—jaundice, stomatitis, gastritis, enteritis, peritonitis; (5) *kidney* (or renal)—gravel, stone, diabetes, ischuria, nephritis, Bright's disease; (6) *bone* and *muscle*—caries, necrosis, exostosis, synovitis, atrophy, &c.; (7) *skin*—urticaria, eczema, herpes, impetigo, acne, lichen, prurigo, &c.; (8) *generative* (or genetic). Under the fourth class are ranged those which are (1) induced by some specific germ or septic particle; (2) conditioned by bad or insufficient food, and are (3) epidemic, endemic, or contagious: *e.g.* (*a*) *miasmatic*—small-pox, measles, scarlet fever, diphtheria, typhus and typhoid fevers, ague, cholera; (*b*) *enthetic* (*i.e.* implanted); (*c*) *dietetic*—fever, scurvy, rickets, bronchocele, delirium tremens, &c.; (*d*) *parasitic*—itch, worms, scald-head, &c.

The developmental diseases are appreciably affected by everything which raises or lowers the general standard of health. Constitutional diseases are acted upon by all that improves or debases the heredity of the race; local diseases are influenced most largely by moral, mental, and physical habits—self-indulgences of some sort or other—and are largely amenable to disciplinary culture and self-control; zymotic diseases are most easily controlled by sanitary authorities and influenced by their arrangements, especially as regards drainage, water supply, and household and personal cleanliness.

The intelligent reader who has followed the course of these chapters as they have proceeded must have seen how complex the frame of man is, and will not be surprised that a structure so complicated, existing in such a variety of conditions, and requiring such nourishment, exercise, management, and control, should be liable to many and various ailments, accidents, disturbances, diseases, &c. He must also feel that, considering men's ignorance of the mechanism of their own frame, of the action upon it of outward influences, and the operation within it of processes and of food, drink, air, &c., the unsanitary condition of human life is not much to be wondered at. If so, he can scarcely think the time, trouble, and thought bestowed on the perusal of these chapters as matter for grudge. If by the study of them any one is led to hold higher views of the value of physiology, of the worth of his own nature and frame, and of the nobility of that being which has had such pains expended on its embodiment, manifestation, and effectiveness—physical, moral, and mental—in art, industry, science, commerce, character, and genius, we shall be gladdened and gratified. Galen, the greatest of ancient medical writers, held the idea that "Physiology is a hymn to the Deity." Who, on glancing back upon what has been stated, can refrain from exclaiming with my Lord Hamlet—"What a piece of work is man! How noble in reason! How infinite in faculties! In form and moving how express and admirable! In action how like an angel! In apprehension how like a god! The beauty of the world! The paragon of animals!" And surely, from what we have learned of the nature of our body and of the requirements of life, health, and usefulness, we must assent to the statement that "the law of the wise is a fountain of life to depart from the snares of death."

BOOK-KEEPING.—CHAPTER XIV.

HOW TO JOURNALIZE — INSTRUCTIONS AND EXAMPLES — CLOSING OF TRANSACTIONS OF WILLIAM KING.

In the foregoing set of transactions we have so far dispensed with a Journal. Many commercial men, thinking that journalizing is too elaborate and quite behind the age, content themselves with having the entries made direct from the primary records of their business—Cash-Book, Day-Book, Bill-Book, &c.—into the final counting-house register, *i.e.* the Ledger, without any intermediary use of a Journal. In the theory of book-keeping by double entry, however, journalizing holds an essential place, and cannot be dispensed with. It not only constitutes the most important element in clerkly culture, but is, in fact, that which imparts and secures perfection to the system. In no way can the qualifications of a professional book-keeper be so readily tested as by seeing that he is efficient and exact in writing up his Journal. In it all the transactions recorded in the primary books are classified and arranged in such an order that they can each be carried to, and posted in, the Ledger without any risk of mistake in their distribution. The Journal is commonly ruled with two contiguous money columns on the right hand side of each page. The inner range of money columns (*i.e.* those which are nearest the left hand on each page) are called the Dr. columns, and in these are to be entered all the debts or receipts; the outer money columns (*i.e.* those which are nearest the right hand of the page) are called the Cr. columns, and into these are to be entered all credits or payments. The Journal thus becomes an aranged record and depository of every transaction, cash or credit, contained in the primary books, and if this is correctly done the summations of the Dr. and Cr. columns must agree, and these, if correctly distributed in posting into the Ledger, will, as a matter of course, be correct, and each of the entries and the whole of the accounts must balance.

The Journal or "posting medium," when fully ruled, requires—(1) On the left-hand side of the folio a space for the insertion of references to the pages in the Ledger into which the postings have been carried, (2) date column, (3) space for entries, (4) debit money columns, (5) credit money columns, as shown in the following page:—

JOURNAL.

Post.	Date.		Dr. £	s.	d.	Cr. £	s.	d.
12		Stock Account Dr., . . .	428	2	3			
		Sundry Accounts Cr.,						
		Amount per Inventory—						
3		Plumber goods account, .				52	10	11
3		Ironmongery account, . .				12	2	3
3		Groceries account, . . .				4	9	5
11		Manure account, . . .				46	9	8
11		Cloth account, ...				312	10	0
						428	2	3
2		Goods Account Dr.,	88	0	0			
3		Plumber Goods Account Cr.,				88	0	0
		Balance at Cr. transferred.						
		Sundry Accounts Dr.						
2		Goods Account Cr., . .				636	18	11¾
		Balances at Dr. transferred,						
3		Ironmongery account . .	33	9	2¾			
3		Groceries " . .	248	8	9			
4		Whisky " . .	355	1	0			
			636	18	11¾			
2		Bad Debts Account Dr., . .	27	15	5			
		Sundry Account Cr.						
		Balances of Accounts Lost, .						
7		Roderick Dhu, ...				27	11	0
7		John Kerr, ...				0	4	5
						27	15	5
		Sundry Accounts Dr.						
2		Commission Accounts Cr.,				37	4	0
10		Scott & Co., ...	25	0	9			
10		J. Mitchell, ...	10	10	6			
8		James Innes, ...	1	12	9			
			37	4	0			
12		Outstanding Debts A/c Dr., .	126	7	11¾			
		Sundry Accounts Cr., . .				126	7	11¾
		Accounts due to Wm. King (For particulars see Account Book).						
		Sundry Accounts Dr., . .	495	0	11			
12		Outstanding Debts A/c Cr.,				495	0	11
		Accounts due by Wm. King, (For particulars see Account Book).						

Post.	Date.		Dr. £	s.	d.	Cr. £	s.	d.
		Sundry Accounts Dr.						
4		Profit and Loss A/c Cr., .				213	3	3¾
		Balances at Cr. transferred,						
2		Commission Account, . .	37	4	0			
2		Goods " . .	175	19	3¾			
			213	3	3¾			
4		Profit and Loss A/c Dr., .	95	7	4			
		Sundry Accounts Cr., . .						
		Balances at Dr. transferred.						
2		Bad Debts Account, . .				27	15	5
2		Trade Expenses Account,				38	4	1
3		Discount Account, . . .				13	13	1
12		Stock A/c — Depreciation,				15	14	9
						95	7	4
4		Profit and Loss A/c Dr., .	117	15	11¾			
1		Wm. King, Capital A/c Cr.,				117	15	11¾
		Balance at Cr. transferred.						
		Sundry Accounts Dr.						
4		Balance Account Cr., . .				2109	9	4¾
		Liabilities of Wm. King,						
12		Outstanding Debts A/c, Balances of Accounts due by W. King, ...	495	0	11			
		Bills Payable Account, .	16	12	6			
		W. King, Capital Account,	1597	15	11¾			
11			2109	9	4¾			
1								
		Balance Account, Dr., . .	2109	9	4¾			
		Sundry Accounts Cr.						
4		For assets of W. King.						
		Balances of Accounts due to W. King, ...				126	7	11¾
12		Stock A/c amount at Dr.				412	7	6
1		National Bank Account, .				1245	10	0
1		Cash A/c: Balance in Hand,				325	3	11
						2109	9	4¾

On turning to the Bill-Book (p. 904), it will be seen that it requires a somewhat more extended ruling. This we exhibit with a journal form annexed:—

BILL BOOK.—Bills Receivable.

Fol.	When Received.	No.	From whom Received.	Amount. £	s.	d.	Date.	Term.	When due.	Entered in Cash Book.	£	s.	d.	£	s.	d.
	1898.															
7	Jan. 31	1	Roderick Dhu, ...	300	0	0	Jan. 31	1 Mo.	Mar. 3	Jan. 31						
11			Bills Receivable Dr. to Bills Received, ...	300	0	0										
			This, as there is only one bill, stands thus—													
			Bills Receivable Dr., ...													
			Roderick Dhu Cr., ...								300	0	0	300	0	0

Bills Payable.

Fol.	When Received.	No.	From whom Received.	Amount. £	s.	d.	Date.	Term.	When due.	Entered in Cash Book.	£	s.	d.	£	s.	d.
8	Jan. 14	1	Thomas Graham, ...	16	12	6	Jan. 14	3 Mos.	April 7							
9	" 27	2	William Gray, ...	100	0	0	" 27	1 Mo.	Mar. 2	Feb. 28						
11			Bills Payable by Bills granted.													
			This takes the form of a journal entry, thus—	116	12	6										
			Sundry Accounts Dr., . . .													
			Bills Payable Cr., ...											116	12	6
			Thomas Graham, ...								16	12	6			
			William Gray, ...								100	0	0			
											116	12	6			

A clerk or book-keeper having before him the various primary books, and knowing that his duty is to extract from these all the materials they contain, proceeds to classify them, and to construct them into a succinct and intelligible *vidimus* of the entire transactions exhibited in them in such a way that at one view the source, the course, and the destination of each and every entry, singly and as a whole, may be distinctly seen. Weekly, monthly, or such stated times as are found to be most suitable, the Journal clerk receives the primary records of the transactions and their attendant circumstances, and his duty is to arrange them in the volume of which he has charge so that they will indicate in the briefest and clearest manner the position and nature of every item in each account. Hence each debtor entry must have a creditor entry exactly corresponding to it, and *vice versâ*, each to each. On the Journal being thus written up, the summations of each account of each page and of the whole period must tally. Then the whole is ready for being posted into the Ledger. The separate accounts having been ascertained, duly indicated, and headed, what has thereafter to be done is to enter each Dr. and Cr. in its proper place in the Ledger. It is in the Journal that the double entry of each transaction really and magisterially appears.

Even though, in an ordinary business, the main personal accounts have had their entries posted immediately from Cash-Book or Day-Book into the Ledger, certain journalized entries will be found indispensable to the closing—at any definite time or in any required circumstance—of a set of double-entry books. Supposing that all the entries have been duly made in the Ledger, before the profit and loss on stock or property accounts can be made, and a balance exhibiting the state of affairs can be obtained, certain abstracts must be made and indications given of the transfers requiring to be attended to from one account to another. As regards the transactions which have been placed before the student in the previous chapters, we set before him (p. 1284) the entries which require to be made that the accounts may be closed, and by tracing these to their sources in the primary record already before him, and noting carefully the manner in which they are stated and arranged, he will see how to journalize, and will be able to observe how in the cases presented to him the instructions given in the preceding paragraphs have been fulfilled. The examples and the instructions will thus become co-interpretative.

The student should now recur to the records made in the Ledger (pp. 1195-97), and trace each entry exhibited in the foregoing essential journal accounts—(1) observing carefully to which account cash is debited and credited, (2) noting that it is rightly so done, and (3) seeing that each has the proper summation given. Let him next investigate why each entry has been placed in the debit or credit, as the case may be, and refer to the respective primary records—Cash-Book (p. 818), Day-Book and Bill-Book (p. 904)—for such entries as they afford, to see that they have been duly dealt with. He had better then turn to each account in the Ledger, and endeavour to follow the entries from the Journal (for as we have already notified, the Journal, as the posting medium, when used in business, precedes the Ledger) into the Ledger, and the balances of those in the Ledger to their respective places in the imaginary or ideal accounts—as stock, bad debts, balance, &c.—to which they are drafted, until they are all found aggregated and summed up in agreement with the last entry of the foregoing Journal in the balance account as £1983 1*s.* 5*d.* As an exercise in *totting* (*i.e.* adding up speedily and correctly) it may be well to sum up the Dr. and Cr. columns of the Journal, and see that they balance correctly, as they ought.

GEOMETRY.—CHAPTER XIV.

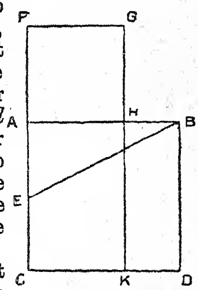
THE PROPERTIES AND RELATIONS OF RECTANGLES—CIRCLES AND THE LESSONS THEY SUPPLY — ANALYSIS OF EUCLID'S ELEMENTS OF GEOMETRY—THE VALUE OF MATHEMATICAL DISCIPLINE.

EUCLID is not only a clear expositor of geometric truth, but an excellent examiner as regards the understanding of it. He has placed before us *ten* theorems, the *proof* of which we have followed, and to the truth of which we have assented. He now brings us to the test of working out a problem involving several of these theorems. The problem here, however, is to bring out and prove the equality of certain rectangular figures one to another, and is, in fact, a new application and development of I. 47. In VI. 30 the same problem appears in another form and for another purpose—viz. to show the agreement of certain ratios one with another. The problem given here for geometrical construction is

PROPOSITION XI.

To divide a given straight line into two parts, so that the rectangle contained by the whole and one of the parts shall be equal to the square on the other part.

Upon A B construct the square A B C D, bisect A C in E, join E B, produce C A till at F, E F equals E B, and from A B cut off A H equal to A F. We have thus realized II. 6, and I. 47. It then follows (1) that the rectangle under the whole and one part is equal to the square of the other part; (2) if the greater part be *added* to the whole, the rectangle under their sum and the greater part is equal to the square of the whole; and (3) the rectangle under the greater and the difference of the parts is equal to the square of the less.



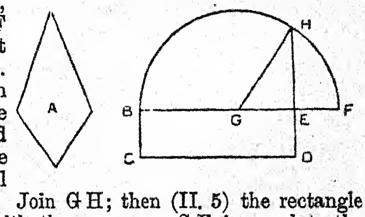
This proposition furnishes the most direct demonstration of the solution of a quadratic equation, and in the construction of a regular decagon Euclid uses it. The steps taken in the two theorems which follow are precisely analogous, and this analogy ought to be carefully observed and traced. They show very clearly the connection between the square on one side of a triangle and the sum of the squares on the other sides, when the angle between these sides is (1) acute or (2) obtuse. Thus I. 47 and II. 12 and 13 together furnish the means of presenting the problems of trigonometry regarding the relations between one side of a triangle and the other two in a form of great practical utility (see TRIGONOMETRY, Chapter IV. p. 377). The student should endeavour to prove that the converse of each of these theorems is true. None of the three last propositions (12–14) in Book II. are used in any of the parts of Euclid usually read, and the last one (14) is included as one of the cases of VI. 22. The student should notice the relation between this proposition (14) and those in I. 42–45. The latter show how a rectangle may be constructed equal in area to a given figure bounded by straight lines; the former provides the means of determining a line such that the square on it is equal in area to any given rectangle (*i.e.* enables us to *square* such a figure).

PROPOSITION XIV.

To describe a square that shall be equal to a given rectilineal figure [*i.e. a rectangle*].

Let A B be the given rectangle, it is required to describe a square equal to it.

Describe a rectangle B D (I. 45). If its sides are equal what was required is done. If, however, they are unequal, produce one of them, B E, to F, making E F equal to E D. Bisect B F in G (I. 10). From G as centre with G B as radius, describe the circle B H F, and produce D E to H; the square on E H shall then be equal to A. Join G H; then (II. 5) the rectangle B E, E F, together with the square on G E is equal to the square on G F. G F equals G H, and the square on G H equals the square on G E, E H (I. 47), and taking away the common square G E, the rectangle B E, E F [*i.e.* the parallelogram B D] equals the square on E H. B D equals A, therefore E H equals A. Q.E.F.



While it is to be remembered that the propositions of

Book II. are not arithmetical or algebraical, yet—when care is taken to secure a proper understanding of commensurable and incommensurable magnitudes, and the adoption of modification of the definition of multiplication to suit the latter—the analogies between arithmetic, algebra, and geometry [*i.e.* between number and magnitude] are very striking, and a knowledge of them is of great value in applied mathematics. For example, if we have a unit rectangle having the sides, B and C, of known dimensions, we may readily find how many times or parts of times any other rectangle, D, contains that given unit by measuring one side of D and learning how many times it contains B, and another side of D to find how many times it contains C, and multiplying the results; thus:—Suppose one side of the perpendicular of D contains B $2\frac{2}{3}$ times, and another, the base, contains C $3\frac{2}{7}$ times; $\frac{8}{3}\times\frac{23}{7}=\frac{184}{21}=8\frac{16}{21}$ [*i.e.* D contains B C $8\frac{16}{21}$ times].

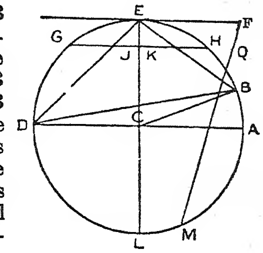
A fine relation may also be established between the geometry of Book II. and solid geometry. It is to be noticed that "Euclid's Elements" were not originally designed to be subsidiary to the development of natural science, the elucidation of universal arithmetic, or the development of art, but to provide a demonstrated system of disciplinary thought, in which, by the regular issue of conclusions from premises gathered from experience, the mind would be led to an extended range of reasoned truth. That they do much besides this arises from their so ably doing what was designed.

Those who study "Euclid's Elements" merely for their extraneous utility, complain of the mode of demonstration adopted in Book II. as incomplete and sometimes difficult. This they propose to obviate by exhibiting its propositions in algebraic formulæ. This may be done thus:—

Proposition 1. $a(b+c+d+\ .\ .\ .)=ab+ac+ad+\ .\ .\ .$
" 2. $ab+ac$[if $b+c=a$]$=a^2$.
" 3. $a(a+b)=a^2+ab$.
" 4. $(a+b)^2=a^2+2ab+b^2$.
" 5 and 6. $(a+b)(a-b)+2b^2=a^2$.
" 7. $a^2+(a-b)^2=2a(a-b)+b^2$.
" 8. $4(a+b)a+b^2=(2a+b)^2$.
" 9 and 10. $(a+b)^2+(a-b)^2=2a^2+2b^2$.

The remaining propositions bring us into the region of incommensurables and quadrates, and would require lengthy explanations regarding statements, operations, and solutions.

Euclid in the "Elements," Book III., explains and evolves the properties of the circle. A *circle* is a figure formed by a point which revolves in a plane surface and always preserves the same distance from a given point, called the *centre.* It is obvious therefore that every straight line which can be drawn from that centre to the circumference is equal, and that any two such lines, called *radii*, drawn directly opposite to one another form a *diameter*. The *position* of a circle is given when its centre is known, and its *magnitude* when its radius is known. A line which cuts a circumference is a *secant*, and one that touches but does not cut it is a *tangent.* The word *circle* is sometimes used to signify only the constantly curving boundary line or circumference, and sometimes the figure or area inclosed by it; hence, sometimes "a point *in* a circle" means a point in the circumference, but a point *within* a circle always signifies a point in the interior. An *arc* is any portion of a circumference, and a *chord* is the straight line which joins the extremities of an arc. The Third Book of Euclid deals with those properties of the circle which are visibly true [*i.e.* perceptible to verified observation], or those which are clearly deducible from properties evident to thoughtfully exercised inspection. A considerable number of the more essential properties of the circle dealt with in Book III. are exhibited in the annexed figure, and a close study of it will enable a thoughtful mind to see how by or through these a very large proportion of Euclid's propositions may be proved briefly and correctly. (1) E F is a tangent to the circle A E D L; (2) G H is bisected by K L; (3) the square on K H is equal to the (oblong) rectangle contained under the two sides H K and K L; (4) the square on E F is equal to the rectangle contained under F Q and Q M—the line F M being (*a*) drawn through F, and (*b*) cutting the circle E A D; (5) if any two chords—*e.g.* G H and D E—are cut as in J, the rectangle contained under the sides G J, J H is equal to that contained under D J and J E; (6) if the point D be moved round the circle, while E and B remain fixed, the angle E D B will preserve the same magnitude throughout, and shall be equal to half of the angle E C B and equal to the angle F E B as well. These are a few of the more palpable of the theorems of the Third Book, and the following out of the suggestions of the foregoing statements will aid the student in comprehending this book easily. It may be as



well to remark that in III. 5 and 6 Euclid has had three cases in view: (1) one in which the circles cut; (2) one in which they touch internally; and (3) one in which they touch externally, but that the last, as self-evident, has been omitted. It must be remembered that Euclid is dealing with visual, not with ideal notions of contact, and that when he uses the word "similar" it refers to absolute sameness of form. In Book III. the reasoning is made rather difficult to follow, by the frequency with which indirect demonstration is employed—in fifteen cases out of thirty-seven. Direct is always more satisfactory than indirect proof, and is much more easily followed. Several proofs of a direct sort have been suggested, but they mainly require axioms, which Euclid is chary of multiplying, such as—If a point be taken (1) nearer to the centre of a circle than the circumference, that point will fall *within* the circle; and (2) further from the circle than the circumference, will fall *without* [*i.e.* outside of] the circle. The student is recommended to try the effect of these in abbreviating and simplifying III. 2 and III. 16.

Book IV. consists entirely of problems. They all relate to the construction of such regular figures as can be described by means of the circle only [*i.e.* which may be inscribed in or circumscribed about circles, and *vice versâ*], such as (1) triangles, to which the propositions 1–5, and 10 relate; and (2) polygons of a *regular* sort [*i.e.* those which have all their sides equal and all their angles equal]—*e.g.* pentagon, square, hexagon, and quindecagon. These are nearly all given for their own sake, and not for future use in the construction of figures in the other books, although the result is in reality that we thus gather up, inductively, the means of practically dividing the circumference of a circle into any number of equal parts, which is not at the same time odd and prime. The means of accomplishing the inscription in a circle of a regular figure having a number of sides at once odd and prime—*e.g.* one of $2^n\times 1$ (such as 17) sides—has been explained in "Disquisitiones Arithmeticæ" by Carl F. Gauss (1801), but they do not fall within the province of elementary geometry. The book is a practical interlude—proving the truth and enhancing the interest of the three preceding books, while exercising and gratifying the mind of the student. It is of no special use in the working out of the propositions in the other books, and may be omitted without detriment to future progress. Problem 1 is merely constructive, 2 and 3 show how to *in*scribe and *circum*scribe an equiangular [*i.e.* I. 5, an equilateral] triangle, and by bisecting their sides [*i.e.* the arcs they form] the circle can be divided into 6, 12, 24, &c., parts; 6–9 give us power to subdivide it into 4, 8, 16, 32, &c., parts; 11–14 supply means of getting at a division into 5, 10, 20, 40, &c., parts; and 16 a section into 15, 30, 60, 120, &c., parts. By 4 we learn that straight lines bisecting the three angles of a triangle meet in the centre of an inscribed circle, and by 5 those bisecting the three sides of a triangle meet in the centre of a circumscribed circle. But the trisection of an angle by the only instruments recognized by Euclid [*i.e.* the straight line and the circle] has hitherto transcended Euclidean geometry. He passes from hexagons to quindecagons at once, because unable by the means at his disposal to inscribe in a circle any regular polygon of 7, 9, 11, 13, or 14 sides.

Book V. has for its subject universal proportion—proportion of numbers, magnitude, and quantities, not of length and spaces only, but of everything really or imaginarily mensur-

able by parts. Hitherto, however, Euclid has employed the word part to signify that which is less than the whole; but he now restricts it to mean aliquot, submultiple, or proportional part [*i.e.* relative magnitude—a unit which is or may be contained in another a greater or less number of times]. The celebrated Dr. Isaac Barrow, the teacher of Sir Isaac Newton, has said that "there is nothing in the whole body of the 'Elements' of a more subtle invention—nothing more solidly established and more accurately handled—than the doctrine of proportionals." This ingenious subtilty arises from Euclid's requiring to secure for his propositions such a universality of application that each theorem should be rigorously correct, whether the magnitude referred to were commensurable or incommensurable as regards the standard unit selected. It is in fact "an application of arithmetic to geometry." He begins with some simple propositions (1 to 6) of concrete arithmetic, which bring out the properties of equimultiples. Next, 7–10, 13 and 14, fill up links in the chain of demonstration, connect the geometrical notion of ratio with the common ideas of (1) greater, (2) equal, and (3) less, and test by results the accuracy of our previous notions when engaged under culturing guidance in working out clearly defined proportions. The notion of ratio of proportion and the interchangeability of proportional parts in relative position is set forth in 11, 12, 15, and 16. The remaining propositions explain and exhibit how magnitudes are proportional by (1) composition, (2) division, and (3) equalization. By regarding "ratio as an engine of operation," Euclid realizes his results in a strictly legitimate, logical form, and yet with far greater brevity than any algebraical method by which it has been proposed to supersede his theoretical exposition, which recognizes no common or conventional unit of measurement whatever. The study of this book in the form which it takes in Euclid's hands is very effective in educating the intellectual powers. Great advantage will be found from the simultaneous study of the geometrical and the algebraical methods: the former will show the reasonable foundations of the latter, and the latter will enable the mind to realize the results of the other more readily.

Book VI. deals with the theory of the similarity of geometrical figures and the conditions of the proportionality of figures which, while the same in form, differ in size. Propositions 1–3 apply the theory to triangles and parallelograms, 4–8 show the similarities of triangles, 9–13 are problems in proportionals, 14–16 consider the proportions of parallelograms and triangles equal in area. These afford a basis for the transformation of every proportion between four lines into an equation between two products, and form the foundations of the Rule of Three. [See Arithmetic, p. 1276]. The theory of ratios here given enables the geometrician to extend the calculus of Book II. into many departments of inquiry. The foundation of mensuration of areas is given in Proposition 23; 27–29 are introduced as means to solve Proposition 30, which is in reality only a special case of II. 11. Proposition 33 enables us to measure angles by arcs, and supplies the mathematical foundation of practical astronomy. With Book VI. the study of figures in a *plane* is brought to a close. Books VII.–IX. consider arithmetical questions, and X. treats of irrational quantities, while XI. and XII. take up solid geometry. Book VII. supplies arithmetical definitions, and explains least and greatest common measures and prime numbers; VIII. treats of continued and mean proportionals; IX. deals with (1) square and cube numbers, (2) plane and solid numbers [*i.e.* those having two or three factors], (3) continues the teaching in proportionals from VIII., and explains what perfect numbers are and how to find them. Book X. investigates and classifies incommensurable quantities, and XI. fixes the definition of solid geometry, deals with the primary relations between lines and spaces, *e.g.* the intersections of planes and the properties of solid figures, such as parallelopipeds, or solid rectangles. Book XII., while treating of prisms, cylinders, pyramids, and cones, and showing that (1) circles are to one another as the squares on their diameters, and (2) spheres to the cubes on their diameters, introduces (3) the highly valuable principle in reasoning known as the "method of exhaustions," which has a far wider reach in elaborative thought than geometry has scope for. Book XIII. applies some of the results of Book X. to the consideration of the sides of regular figures, and instructs the student in the methods of describing the *five* regular solids, viz. (1) *tetrahedron*—four triangular faces and four vertices; (2) *cube*—eight vertices and six square faces; (3) *octahedron*—six vertices and eight triangular faces; (4) *dodecahedron*—twelve pentagonal faces, being three at each of its twenty vertices; (5) *icosohedron*—twenty triangular faces, being five at each of the twelve vertices. It concludes with the *scholium* that "no other regular solid exists except these five." This was the last of the books written by Euclid. Hypsicles of Alexandria, it is generally said, composed two supplementary books, XIV., XV., treating of the relative proportions of the regular solids and of their inscription in one another.

The "Elements of Euclid" held their place as the standard work on disciplinary geometry as long as Greek continued to be used as a common language among the cultured. The works of this honoured and eminent geometrician have, however, long since ceased to be studied as a whole. Books VII.–X. are scarcely if ever studied, and of Book XII. the two first propositions are generally regarded as the only ones useful to be read. Euclid did as much as could be done in his age to show how by reasoned thought alone, employing the smallest possible number of first principles, a large and ever-enlarging number of clearly demonstrated truths could be educed and so interwrought with each other as to present a compact and consistent whole, remarkable for simplicity of evolution and the grandeur of the truths they permanently embody and exhibit. It is quite true that other methods suggested by Roberval, Pascal, and Desarques in the seventeenth century, by Poncelet and Chasles, De Morgan, Boole, Clifford, and many others, have imparted new power and fresh interest to geometrical science; but the severe rigour and sedate elegance, the forethought and the beauty of Euclid's demonstrations, speaking generally, constitute as a whole one of the most masterly structures of abstract speculative thought which men have reared for the blessing and glory of humanity. The abstract here given of the contents of this wonderful book may lead some to comprehend more thoroughly the value of Euclid's work in amount as well as method. The examples of the mode of study presented in the thorough though simplified form imparted to the First Book by "The Home Teacher" will, we trust, be effective in proving that Euclid is not a dry repulsive repository of difficulties, but is a fine field for mental exercise, and a permanent training in practical logic. We have sought to make clear and unmistakable the theory and practice of geometrical reasoning as a mode of thought, capable of being applied to and used in illustration of all the phenomena of nature and art—the entire system of the visible universe and every representation of it—and yet emphatically a profoundly useful culture for those mystic powers of mind which seek truth and rest not till they find it. Our aim may not have been very ambitious, nor may our achievement appear to be great, but we may confidently say to our students, in the words of Stephen Hawtrey of Eton, "When the learner shall have gained an intelligent insight into [even] the First Book of Euclid, he may be assured, for his comfort, that he will have made a most valuable acquisition, the benefit of which he will feel in every study he may enter upon, and through all his future life."

BOTANY.—CHAPTER XIV.

BOTANICAL CLASSIFICATIONS, ARTIFICIAL AND NATURAL.

In this, the closing chapter of these botanical lessons, we can scarcely serve the student better than by supplying him with some knowledge of the systems of classification adopted by modern expositors of the phenomena of vegetation. It goes, we suppose, without saying that the gracious odours and the graceful forms of plants lend fascination to the art of observation. Scientific investigation must be precise, relevant, well-considered, and as exhaustive as possible, and it should result in a distinct classification of the objects examined, such as may facilitate the separate and thorough study of each group of objects in their proper relations one to another, and of the whole of these as an entire subject. To accomplish this, we must note the distinguishing characters of the individual

objects observed, and arrange them in groups possessing real specific marks of likeness, and if possible place these groups in distinctly arranged relations of co-ordination or of subordination. Thus we may reduce the multiplicity of things seen to some order, and begin to understand how they may be set in series and remembered. Of course, we must have a purpose in doing this, and this purpose fixes the specific examination which requires to be made into the qualities of things. When we have gathered together such groups of individual things as exhibit a close resemblance to each other we conjoin them in thought, under the most marked peculiarity in which they are alike—especially if it is a likeness (1) which forms an invariable index to the possession of any number of readily known subordinative characteristics, and (2) which includes under it the largest possible number of marks of resemblance. Botany, perhaps better than any other science, furnishes certain and lucidly arranged classifications marked by names both common and technical, brought fairly within the scope and management of thought, and built up into a complete and compact form, clearly indicative of the relations and connections subsisting among plants, as subkingdoms, classes, orders, genera, sections, species, varieties, races, variations, &c. Referring to our first chapter (*p.* 61) for notices of earlier schemes of classification, we shall now refer only to those having material value in relation to modern botany.

Otho Brunfels of Berne, by his "History of Plants," early in the sixteenth century, restored botany to a place among scientific studies; and Andreas Cæsalpinus of Padua, in his "De Plantis" (1585), became, as Linnæus states, the earliest true systematic botanist. He took the fruit as the characteristic, and arranged plants in fifteen classes. John Ray's enlightened views of classification induced him to separate flowerless from flowered plants, and to distinguish between monocotyledons and dicotyledons. Rivinus (1690) proposed a classification founded on the form of the corolla, and this, improved by Tournefort, was accepted throughout the Continent till the illustrious Swede, Linnæus, proposed his index-names for the plants presented in the book of Nature. His method of nomenclature, called the Sexual System, is artificial, and does not follow the affinities of plant-forms. Linnæus was a logical precisian. He did not see that natural history does not admit of rigorously case-hardened definitions, eternized in a phrase. Yet he did much to advance botanical study. He improved its phraseology, simplified its awkward and inconvenient nomenclature, enforced fixity of meaning in the language used, and provided technical expressions of remarkable terseness. Not as a mere namer of plants, but as a systemizer of knowledge and a guide to observers, did he give forth his revolution in the form of pursuing his favourite study. He thought he had caught the divine soul and essence of plant-nature in the inflexible grasp of his logical iron-hand; but lo! the changeable Proteus fled elusively from him, leaving little else than the loose wrapping of words in his hold. Even though it was so, great advantage accrued to science from having a universal system by which to class, and in accordance with which to communicate, in understood terms, the facts acquired in the course of research into the plant-world for which opportunity arose as voyagers and travellers strove to enlarge the boundaries of experience. Though the Linnæan system of classification has fallen into disuse, however, the employment of its nomenclature in common books and the need of the scientific student's being able to carry with him a knowledge of the language prevalent in botanical literature, render it advantageous to present some brief notice of the Linnæan lexicology.

The Linnæan system is founded on the number, situation, and proportion of the essential organs of fructification, denominated *andria*, stamens, and *gynia*, pistils. The vegetable kingdom is divided into twenty-four *classes*—twenty-three of flowering and one of flowerless plants, distinguished by their *stamens.* These are subdivided into *orders*, known by their *pistils.* The names of the classes and orders are of Greek derivation, and allude to the functions of the respective organs. The first eleven classes are distinguished entirely by the number of stamens, indicated by the Greek words for one, two, &c., combined with *andria.* The orders are similarly denominated by prefixing the same numerals to *gynia*—*e.g.* jasmine, having two stamens and one pistil, is placed in Class II. and Order I. (*i.e. Diandria monogynia*); and the common daisy, "the constellated flower that never sets," because its stamens are united by their anthers, belongs to Class XIX.; as the florets on the disc are perfect, while those on the ray, having pistils only, are imperfect, and therefore superfluous, it belongs to order II. (*Syngenesia superflua*). In the next two Gr. *icos*, twenty, and *poly*, many, are used. Thereafter with similar numeral prefixes—*dynamia* (powers), *adelphia* (brotherhoods), *syngenesia* (growing together), *œcia* (households), and *gamia* (marriages)—supply the other derivations, and the terms become readily self-explanatory.

Objections have been taken to this system even as an artificial classification. Unless the plant is in full flower, having stamens and styles perfect, the class and order cannot be determined. Different flowers on the same plant, in many instances, vary in the number of their stamens. The characters of the stamens and pistils are not always so easily discriminated as might be thought. It is sometimes rather difficult to distinguish Dodecandria, Icosandria, and Polyandria from each other. The stamens do not invariably exhibit and preserve their proportionality in Didynamia and Tetradynamia. Mistakes are readily possible between Monadelphia and Diadelphia. It seems that if the violet belongs to the Syngenesia, the cyclamen should also be included among them. Many of the characteristic appearances of Monœcious and Diœcious plants are left unnoticed. A still more fatal flaw was that when carried out rigidly it led to the separation, in many instances, of species of the same genus. This, however, Linnæus himself knew and rectified so far, by placing the name of the species in Italics in the classes and orders to which, by classification, they belonged, and referring to the proper genus for the scientific description. The short phrases to which the characterizing of classes and orders was restricted convey no notion of the genera of the plants to which they are applied, and hence Loureiro, the Portuguese botanist, when determining the plants of China according to the Linnæan system, classed the Hydrangea as a primrose. Linnæus was not a physiologist, and though he felt the need of a natural arrangement, and even made attempts to achieve one, he has left no valuable views regarding the embryogenic process on the outward agencies of which his system is based.

The Linnæan system is a simple and ingenious method for linking together in thought that grand universe of wise design and regularly evolving plan which constitutes the wondrous truths of the plant world. Led by the "Prolepsis Plantarum" of Linnæus, and unacquainted with the fact that Ludwig and Wolff had made approaches to the same theory, Goethe the poet, in his "Metamorphoses of Plants," showed that all the organs of plants, however various their names and dissimilar their functions, are only modifications of the *leaf.* His views were stated so clearly and argued so convincingly that they have now become the very basis of organography in its twofold elements of morphology and structural botany. Jussieu's ideas harmonized with Goethe's theory. De Candolle modified Jussieu's classification somewhat. Then a natural system became possible, and for a time this "combinate" modification prevailed.

Jussieu and De Candolle's *Natural System of Botany* takes into consideration the whole organization of the plant, with its properties and peculiar habits; the most striking genus of a tribe of plants gives name to the order—*e.g.* the rose forms the type of the order Rosaceæ. The whole vegetable kingdom is divided into fifteen classes, and the genera into one hundred orders. The cryptogamic plants—*i.e.* those whose seeds are without cotyledons or seed-leaves—form Class I. The others consist of such as have seeds with one or two cotyledons. Plants having stamens (1) inserted below the pistil, (2) on the calyx, or (3) on the seed vessel afford three distinct classes of monocotyledons. Plants with two cotyledons follow. From distinctions in the flower-leaves they are divided into—(1) apetalous (without petals), (2) monopetalous (single-petaled), and (3) polypetalous (many-petaled). These are again subdivided, according to the insertion of the stamens and the union or separation of the anthers which they support, into ten classes. Diclinous plants, so called from the separation of the stamens and pistils, complete the number, fifteen. These classes are

all distinguished by numbers, each having a short definition of their essential character given.

But Goethe's ideal of vegetable physiology induced even greater changes in the opinions of men regarding the inner nature and outer forms of plants, and have led to the dismissal from the science of many complicated descriptions and many unintelligible distinctions. Among those who embraced the philosophic doctrines of the structure and physiology of plants, Dr. John Lindley acquired great distinction, and his writings on systematic botany have done much to advance the scientific study of the vegetable kingdom.

Lindley's classification arranges plants into seven classes, thus:—

A. ASEXUAL (OR FLOWERLESS).

CLASS I.—*Thallogens*, stems and leaves undistinguishable.
CLASS II.—*Acrogens*, stems and leaves distinguishable.

B. SEXUAL (OR FLOWERING).

CLASS III.—*Rhizogens*, fructification springing from a thallus.

CLASS. IV.—*Endogens*, fructification springing from a stem; wood of stem always confused; youngest in the centre; cotyledon single; leaves parallel-veined and permanent.

CLASS V.—*Dictyogens*, leaves net-veined and deciduous; wood of stem (when perennial) arranged in a circle, with central pith.

CLASS VI.—*Gymnogens*, wood of stem always concentric; youngest at circumference; cotyledons, two or more; seeds quite naked.

CLASS VII.—*Exogens*, seeds inclosed in seed-vessels. This class is divided into four subclasses—viz. (1) *Diclinous*, (2) *Hypogynous*, (3) *Perigynous*, and (4) *Epigynous*, which are again subdivided into various races and natural orders.

Lindley was not alone, however, in advocating the arranging of plants according to a natural method and in endeavouring to reduce to a systematic form a knowledge of morphological and structural botany. Robert Brown, Endlicher, the Hookers and Bentham, the Balfours, Bentley, Dickson, Henslow, Grindon, Henfrey, Babington, Sachs, Prantl, &c., all taught how plants were to be grouped in accordance with their affinities—morphological, structural, or physiological—and the natural system has been thoroughly established as the basis of botanical classification.

The following table will be useful to the student as giving an arrangement of the "natural system," which is perhaps of the greatest *practical* use, being free from some of the complications of the more scientific and elaborate systems. On this account we recommend it especially to the beginner. The various orders and genera of the classes and sub-classes will be found in any Flora, and the student who is going fully into the classification of plants ought to have a Flora constantly beside him, if possible one for the district in which he is botanizing:—

DIVISIONS OF THE NATURAL SYSTEM.

DIVISION A.—PHANEROGAMOUS OR FLOWERING PLANTS.

CLASS I., *Dicotyledons or Exogens.*—Embryo furnished with two opposite cotyledons, rarely more, and then much divided or whorled. Stem increasing by external layers. Leaves with branching veins, the ultimate ones reticulated. Flowers arranged in five or two parts, or multiples of these numbers.

Sub-Class I., *Thalamifloræ.*—Petals several, distinct, and are, as well as the stamens, inserted into the receptacle (*hypogynous*) below the ovaries.

Sub-Class II., *Calycifloræ.*—Petals several, distinct, and are, as well as the stamens, inserted into the calyx (*perigynous*).

Sub-Class III., *Corollifloræ.*—Corolla with the petals united (*monopetalous*). Stamens mostly inserted upon the corolla (*epipetalous*).

Sub-Class IV., *Monochlamydeæ.*—Perianth, single or none.

Sub-Class V., *Gymnospermeæ.*—Ovaries open, destitute of style or stigma. Perianth, none.

CLASS II., *Monocotyledons or Endogens.*—Embryo furnished with one cotyledon, or, if more, alternate. Stem increasing and lengthening by new matter within; woody bundles confused. Leaves parallel-veined, and withering on the stem. Flowers arranged in three parts, or multiples of this number.

Sub-Class I., *Petaloideæ.*—Floral envelopes, verticillate, mostly petaloid. Perianth single, or sometimes none.

Sub-Class II., *Glumaceæ.*—Perianth, none. Floral envelopes imbricated, consisting of chaffy scales or glumes.

DIVISION B.—CRYPTOGAMOUS OR FLOWERLESS PLANTS.

CLASS III., *Acotyledons or Acrogens.*—Plants bearing no true flowers; the organs of reproduction are bodies resembling seeds, called spores, having no embryo, consequently without any cotyledons. Increase of growth takes place at the apex of the stem when present, and the woody bundles are arranged in a zigzag manner. The venation of the leaf or frond is by repeated forkings, often rather complicated.

Systems, classifications, and nomenclatures, of course, vary with the views of morphology held by the investigator. Lindley, perhaps, gave a too predominant place to phanerogamous plants. Of late, since the study of the Cryptogamia has been pursued with more than ordinary zeal, other systems of classification have been proposed, in which the latter acquire more prominence. We must premise that the word *kingdom* includes all plants; that every subordinate grouping is an ideal aggregate—subkingdom, class, order, family, &c.—formed by selecting some special peculiarity to be regarded as its characteristic; that since the views advanced by Mr. Darwin have revolutionized the idea of species, it has been thought best to take as the basis of groups the correlation of organs, so that by comparison with others the relative position of any group in a scheme of classification may be either ascertained or determined; and that all groups are to be regarded not as final, but as matters of convenience, subject to rearrangement and liable to modification as knowledge advances and fresh facts emerge. Taking these things into consideration the following classification has recently been suggested:—

Subkingdoms.—I. Thallophyta (Algæ or Fungi)—plants (*a*) very simple in structure, often unicellular, (*b*) possessing no true roots, (*c*) presenting no fibro-vascular tissue, (*d*) having no separation of stem and leaf such as is seen in higher plants, and (*e*) reproduction varied. Under it are contained four classes:—1. Protophyta or Schizophyta—increasing by multiplication (*i.e.* vegetative division) of cells into equal or unequal parts, without (known) sexual reproductive organs, and with or without chlorophyll. 2. Zygosporeæ, whose reproduction is effected by the union (conjugation) of similar or nearly similar cells, and whose product is either (1) a zygospore developing (*a*) motile or non-motile cells, or (*b*) a new plant; or (2) the plasmodium developing sporocarps or spores. 3. Oosporeæ, whose reproductive organs are—female, *oogonium*; male, *antheridium*. 4. Carposporeæ, producing after fertilization a sporocarp, from which the spore or spores develop.

II. Bryophyta (Hepaticæ and Musci)—plants (1) developed either (*a*) directly or (*b*) indirectly from a spore, (2) sexually reproductive, (3) presenting no fibro-vascular tissues, (4) possessing no true root, and (5) having stem and leaf rarely consisting of a *thallus*. The fertilized germinal cell develops a special structure (in the second generation) called the sporogonium, containing the spores. Of these the two classes are: 1. Hepaticæ, developing from the spore a thallus or thallus-like stem, from which is produced the *antheridia* and the *archegonia*. 2. Musci, developing from the spore a filamentous thallus, from which originate buds, and from these the leafy axis rises. The antheridia and archegonia develop either (*a*) at the apex or (*b*) on the side of the stem. The calyptra is formed by the carrying up of the archegonium on the sporogonium.

III. Pteridophyta (Filices, Equisetæ, Lycopodiæ)—plants (1) developing a thallus-like structure (*prothallium*) bearing (first generation) the sexual organs, and (2) from the germinal cell, fertilized, producing (second generation) a spore-bearing plant having true root, stem, leaves, and presenting fibro-vascular tissue. They are arranged in three classes:—1. Filices—plants having root, stem—usually unbranched, and a few large leaves—usually branched. Their sporangia are developed (1) on the under side, (2) on the margin, or (3) in the interior of (*a*) ordinary or (*b*) specially modified leaves or parts of leaves. The spore may be either of one sort or of two sorts—microspores or macrospores. 2. Equisetæ—plants (1) having roots (monopodially) branched, (2) stems much

branched, usually in whorls, and (3) numerous leaves, small, sheath-like, and toothed. Their sporangia develop in clusters on the under side of stalked shield-like leaves, arranged in alternate whorls, forming a compact cone-like spiky structure at the end of (*a*) green or (*b*) brown stems. The spores (which are of one kind) are ejected by hygroscopic elaters. 3. Lycopodiæ—plants having (1) root and stem branched dichotomously, and (2) usually a number of small leaves. Their spores may be of one kind only, or both microspores and macrospores.

IV. Phanerogamia—These plants (1) possess roots, stem, and leaves; (2) present fibro-vascular tissue; (3) develop ovules in a special part of the flower, which when (*a*) mature and (*b*) fertilized become seeds, and by germination grow into a new plant. Its classes are two: (1) Gymnosperms—whose ovules are not inclosed in a special receptacle or ovary, as Coniferæ, Cycadaceæ, and Gnetaceæ; (2) Angiosperms—whose ovules are inclosed in an ovary, including by far the greater majority of flowering plants. The Angiosperms form two subclasses: (1) Monocotyledons, and (2) Dicotyledons—with the distinctions between which the student is already sufficiently familiar. The Phanerogamia constitute the subkingdom B—sexual (or flowering)—in the classification of Lindley, and Division A of the second natural system epitomized.

It will most probably be found by the student advantageous to have a form of direction for the systematic observation of plants. The following outline of a plan practically serviceable, if it does not supply, may suggest, what to observe and note in botanical study:—(1) Habitat—place of (natural) growth and the character of it; (2) root, if any—of what kind; (3) stem—general character, whether simple or branched, erect or twining, &c.; (4) buds and axil-branches—how and when formed; (5) leaves—their duration, position, arrangement, insertion, division (simple or compound), composition, form, margin (and its various characteristics), whether stipulate or exstipulate, mode of vernation and venation; (6) inflorescence—spiked, racemed, pannicled, umbeled, forming into a head or a corymb, &c.; (7) bracteal appendages—bract, bracteoles, involucre—single or many whorled; (8) flower—peculiarities of calyx, corolla, and æstivation; stamens (anther, pollen, filament), pistils, ovary, disc, receptacle, whether the flower is regular or irregular, unisexual or bisexual, style, stigma, placentation, axile or parietal; (9) fruit—pericarp and seed, indehiscent or dehiscent, testa, albumen, embryo, fertilization; (10) surface coverings and appendages of plants—protective, defensive, attractive, nutritive, or scansorial. Either in a botanical note-book or in an herbarium, such particulars as can be entered on the points suggested should be carefully set down, with the date of gathering attached, and any special circumstances attending it. The habit of careful observation, distinctness of statement, and accuracy of description is one which botany affords special scope for acquiring. The more specific and technically precise the terms employed the more likely are the notes to be of future value.

The endeavour made in the foregoing chapters of these lessons on Botany to awaken a popular interest in the phenomena of the vegetable kingdom, and to impart in a plain, and in some measure, an informal way, a fair knowledge of the general facts of plant-life, will not, it is hoped, be found satisfying but stimulating. The varied forms, the attractive beauty, the numerous uses, the important products, the wise arrangements, and the endless sources of interest which "Nature's favourite children" bring before the student's mind have been indicated; but have not been—can they, indeed, ever be?—fully noted and explained. The methodical study of botany implies a great deal more than we have been able to overtake. We have supplied such elementary statements regarding the nature and number of the primary organs of plants, their relative uses, special positions, peculiar tissues, usual arrangements, and general results, as seemed to be necessary for the information of those who desired to observe vegetable growth. It has been our aim to explain the order and manner in which the various parts of plants develop, and the means and mode of their multiplication. The functions plants fulfil, the products they supply, the fruits they yield, the purposes they subserve, the changes they undergo, the charms they possess, the pleasures they impart, the care they need, and the "overpayment of delight" they return for it, as well as the mission of the wayside and woodland wildings of creation to cheer, refresh, and gratify, have, to some extent, engaged our attention. But scientific botany leads far beyond these limits. Botany investigates the organization (*i.e.* the form, structure, and functions) of plants; but ranging far more widely, it includes in its range everything relating to the vegetable kingdom—living or fossil. It claims as within its scope all the plants which the earth nourishes—from lichen or moss to forest-giant, and inquires concerning their distribution over the globe now and in previous periods. It accepts as its proper task the arrangement, classification, and naming of all vegetable productions, and takes under its comprehensive view the external forms, the special functions, and the known (or possible) uses of plants. It examines the simple cell in which vegetation originates, and follows the course of its development until its full maturity is reached; the tissues which compose the different organs of plants from their minutest structure to their mightiest manifestations, and the relations which subsist not only between each part of the vegetable economy, but among all the myriad members of the vegetable world—whether existent now or found in fossil forms "after the flight of untold centuries." A theme so vast as this outsweeps the space—and far exceeds the power—devoted to this popular statement and review of such of the teachings of botany as could be made interesting, plain, instructive, and if possible stimulating to the general reader and the inquiring student. We trust, at least, that the perusal of the pages allotted to the consideration of this subject shall add fresh interest to wayside and hedgerow, copse and dingle, mead and glade, moorland and sylvan scene, garden and forest, valley-course and mountain crevice, orchard and field, park and lawn, the cottage-plot and the sacred turf of the graveyard. In one and all of these

> "'Tis wise to let the touch of Nature thrill
> Through the full heart,"

where plants of any kind bring glad sensations, sweet remembrances, the measureless content of associations of growth, gift, fruitage, and merriment—while conning the lessons taught by those inquiring thinkers who read creation's varied page with living feeling—lessons which show men that those myriad vegetable products,

> "From the first bud, whose verdant head
> The winter's lingering tempest braves,
> To those which, mid the foliage dead,
> Sink latest to their annual graves,
> Are all for use, for health, or pleasure given:—
> All speak in various ways the bounteous hand of Heaven."

GERMAN LITERATURE.—CHAPTER II.

FROM LEIBNITZ TO KANT, AND LESSING TO RICHTER.

Shortly after the reformer's death the intellectual excitement of the Lutheran era degenerated into civil and ecclesiastical strife. The vigour, originality, and individuality of that period of earnestness passed away. Literature was manufactured in associations. Imitation and conventionality coalesced into clubs and unions, and mediocrity exaggerated itself into notoriety. Poets ceased, and poetasters increased. Opitz (1597–1639) was greeted as the Virgil of Germany, and excused himself when charged with cowardice by saying he acted "like his model-poet Horace." Hoffmanns-Waldau (1618–79) and Lohenstein (1635–83) took to French fashions of thought and expression, and along with Günther and Wernecke held the leading places in the literary sect known as "the second Silesian school of poetry." Of course, the succession of incidents leading to, culminating in, and resulting from the Thirty Years' War (1618–48), had considerable influence in producing this lamentable unletteredness. The materials for Schiller's History and the Wallenstein tragedies were only then accumulating. Social and political life in those times did not seem poetic, and unfortunately the scholars of that age did not think German a language of sufficient

gravity and grace to give adequate expression to the products of polite literature. Out of the list of these tedious and pedantic writers, we may first name Hans M. Moscherosch (1600–69), author of a coarse, humorous novel, "Philanders von Sitteuwald;" S. Greifenson, whose satiric "Simplicissimus" (1669) is a sort of German "Gil Blas;" Barthold Brockes (1680–1747), who had the good sense to introduce Pope's "Essay on Man" and Thomson's "Seasons" to German readers; and Balthasar Schupp (1610–61), who endeavoured then to show "that even our homely mother-tongue can be turned to very polite uses," despite the practice of the learned and Latinized. One world-known name must not be omitted—that of Gottfried W. Leibnitz (1646–1716). His chief works—those which have affected the mental history of the race—are not, we admit, composed in his own land's language, nor are those which are written in German distinguished by clearness and elegance. In 1838–40 E. Guhrauer collected and edited the German works of this illustrious thinker—founder of the Berlin Academy of Science, jurist, mathematician, historian, metaphysician, the most erudite of modern philosophers, and the father of German speculative science. It says much for the man of piercing intellect and tireless industry, who wrote as a master not only the classical languages, but many of the tongues of Europe, and was held in estimation as an intellectual potentate throughout the bounds of civilization, that he taught in his native language the practical common-sense of life, and gave in his German works such thoughts as these:—"Happiness consists in a true and harmonious development of all the faculties of our nature, and unhappiness may be regarded as originating in some disease in, or injury of, our life-powers, in consequence of which their unity of action is interrupted; pleasure, like our daily diet, must be regulated by reason; the joy which springs from internal harmony and order, enlightened reason, and love of goodness, prepares us for the enjoyment of the general harmony and beauty of the universe; in concord with ourselves and with the universe in which we live, true happiness is found; when we remember that the soul is immortal, and that all goodness in this world produces results in the world to come, we see at once that the happiness which springs from wisdom and goodness is indescribably grand and glorious." Such words as these, much more than mental theories and logical investigations and discussions of an abstruse character regarding monads, ultimate atoms, sufficient reason, and contradiction, moved the minds of the men of the fatherland.

But even those principles of "pre-established harmony"—as the bridge across which we pass from the appearances of space and time to the realities of immensity and activity—were brought within the domain of German thought by the great drill-sergeant of philosophy and ready-reckoner of science, Christian von Wolf (1679–1754), who expounded them in the vernacular. He "was recognized at that time as the second greater Leibnitz and head-philosopher of Nature who, by mathematical method, had, as it were, taken Nature in the fact and illuminated everything;" and had, as Frederick the Great when Crown Prince said, "carried light into the darkest places of metaphysics." His "Vernünftige Gedanken von den Kräften des Menschlichen Verstandes," and his academical "Philosophia Rationalis Logica," exhibit great methodical skill, indefatigable industry, and application. Wolf dexterously dovetails an idea of Locke with a statement of Leibnitz, brings an aphorism of Bacon into harmony with a theorem of Spinoza or a determination of Descartes. Philosophy with him means the perception of the rational grounds, and therefore the causes of existing things and of the changes possible in them. His systematization of the Leibnitz speculations, known as the Leibnitzo-Wolfian Philosophy, became the accepted doctrine of thinkers in many lands. Johann J. Engel presented philosophy in a popular form in "Der Philosoph für die Welt"—which is the exposition of the views held at this period on the educational value of the investigations instituted into the operations of mind and the forms of expression best suited to man's needs. Some comedies of his, vital with racy dialogue, were justly popular as stage plays; but "Herr Lorenz Stark" (1801), a novel, in its simplicity and homely moral influence, holds rank as the German "Vicar of Wakefield."

Germany, building itself up by self-energized exertion into strength of race, naturally yearned also to build up a strong-minded people, whose language, thought, and interests would be national, and whose culture would be based on a literature and philosophy of home-growth, appealing to the aspirations of an independently embodied people. To act on the masses it was necessary to have a vernacular free from the Gallomania and so-called refinement of the capital of "le Grand Monarque," and pervaded by the genuine German *Volksmeinung.* To speak one's own language must have a salutary influence on patriotic sentiment. Frederick the Great, Carlyle's hero and the chief war-leader in the middle of the eighteenth century, furnished the poets of his time with a splendid subject for flattering odes, gave rise to a series of battle-songs, and supplied many incidents claiming the transfiguring touch of the popular bard. By the influence of his royal patronage he encouraged the development of science, art, and scholarship. His warlike achievements, the aspirations they excited, and the mental activity they aroused, assisted much in influencing literary efforts; but personally he did very little to advance and improve the national literature, as all his predilections were in favour of French forms of letters and languages. In conversation he spoke sometimes German, sometimes French—whichever seemed to afford the strongest expression. "He had," says Carlyle, "learned the art of speech from those old French governesses and in those old and new French books of his." His wish that French literature should alone be cultivated in Germany, and his project of making Berlin another Paris, caused Schiller to complain that "the German Muse" was—

> "Scorned by her country's greatest son,
> Thrust from the mighty Frederick's throne,
> Unskilled her worth to prize."

"Certain enough it is" that Voltaire was Frederick's "supreme in literature," his "chief thinker in the world; unofficially the chief preacher, prophet, and priest of this working king;" and this German king's first book, "Anti-Machiavel," in French, edited by Voltaire, in September, 1740, was welcomed with such applauses as are now incredible. "Ten years later "Les Œuvres (*poëtiques*) du Philosophe de Sans-Souci," were printed in three thinnish quartos. This notable hero-king-philosopher, statesman, and historian, as the twenty-one volumes of his published works show, can advance a fair claim to literary distinction; but though he was a Prussian *könig*, and in his own way, too, a *vaterlands freund*, he must be ranked rather as a French than a German author. His intellectual bias was in this respect anti-Teutonic. It was well for Germany that Lessing exerted his Herculean intellectual powers against the foreign influences which oppressed and bewildered so many of his predecessors, and would have deprived the literature of his native land of its national character and that purposeful power which the vernacular of a race exercises over the souls of a people.

Johann J. Breitinger (1701–1776) was born at Zürich, and died there. Besides composing "An Attempt to compare the German Poets with those of Greece and Rome," he translated several of Cicero's writings successfully, and added some sweet songs attuned to the music of his native land,

> "Where Father Rhine in early youth is seen."

Johann C. Gottsched (1700–1744) was a sound grammarian of the German language, but somewhat unduly assumed the position of the reigning king of German literature—for the time being. For example, Frederick the Great told how, in talking with him once, he spoke of the advantage of the French in being able to use a word in a complex signification for which they had in German to scrape together several different expressions, when Gottsched imperially replied: Das wollen wir noch machen! (That shall we have mended!) As the head of the Leipzig school, which was under French influence, Gottsched maintained a long controversy against Johann J. Bodmer, who held a chief place in the Zürich school, and was inspired by admiration of English writers. The fray waged by the Gottschedians and the Bodmerians was carried on with considerable spirit and noise. Out of it grew the distinction of styles known in Germany as the classic

and the romantic. Gottsched is pedantic, and being deficient in tact, skill, and genius to give his erudition life, became a stylist rather than an inspirer. He lectured on "The Theory of Literary Art," and exemplified his tenets by paraphrasing (one can scarcely call it translating) Addison's "Cato" and Racine's "Iphigénie." His poems show little ideal power.

Bodmer (1698–1783), his opponent, wished to infuse the spirit of antique literature into Germany, and as a model of the style in which imagination and emotion are both expressed and stirred, he translated Milton's "Paradise Lost." This he next proceeded to imitate in "Die Noachiade," the lumbering hexameters of which, though sometimes vigorous, were not always harmonious. He accomplished more good by the republication of specimens of ancient poetry than by his own productions, and he excited others to aim at excellence, though he did not reach it himself. He opposed his "Principles of the German Tongue" to those of Gottsched.

Albrecht von Haller (1708–77) was at once anatomist, physiologist, botanist, and poet. He was professor of medicine at Göttingen and president of the Academy of Science. The Emperor Francis I. ennobled him in recognition of his genius and attainments. His poems abound in original ideas, his verse is harmonious, and his employment of the vernacular pleasing. "Die Alpen," a descriptive poem written during a tour among their striking scenery, is his best production. His smaller poems and some of his didactic pieces show power and pathos. Schiller says: "Haller is great, bold, impetuous, and sublime, but that which constitutes the essence and reality of beauty, it has not in his poems been his fortune to attain."

Friedrich von Hagedorn (1708–54), who dwelt some time in England and studied many of the works of its best writers, is as a lyric poet easy and graceful, as a fabulist full of simple sprightly fancies, and as an epigrammatist lively, witty, and skilful. His style is refined, yet popular and characteristic. Of his "Johann der Seifensieder" (Soapboiler) the excellence is acknowledged on all hands. Justus F. W. Zachariæ (1726–77) held the office of professor of poetry. He translated Milton's "Paradise Lost," imitated Thomson's "Seasons" in his "Tageszeiten," a beautiful descriptive poem, only equalled in tenderness and grace by his "Die Vier Stufen des Weiblichen Alters," in which the four eras of woman have been so sketched as to win much admiration. His satire, in "Der Renomist," of the bully-roisterer of the universities is particularly strong. The comicality of "Das Schnupftuch" is pleasant, his parody on the "Rape of the Lock" is smart, and perhaps we had better not mention "Der Murner in der Hölle." C. F. Weisse (1726–1804) wrote with dignity and elegance. As a dramatist his "Jean Calas," a tragedy, is good, and so are several of his lighter comedies. "Der Kinderfreund" and its sequel "Der Briefwechsel" form the chief pillars of his reputation. G. W. Rabener (1714–71), for his sound views on education, the pith of his sarcasm, the cheerfulness of his humour, and the correctness of his style, is worthy of the highest praise. There is a fund of wit and humour in his "Das Deutsche Wörterbuch," "Klims Todtenliste," "Das Madchens Von Ersten April," &c. Christian F. Gellert (1715–69) brought with him from the little town of Heinichen among the Saxon mountains the indomitable spirit of industry which led him into the chair of philosophy in Leipzig. He was a popular moralist, and his "Fabeln und Erzählungen" won him a wide reputation. His "Swedish Countess," a novel, is readable and interesting. Some odes and songs are found in collections still, but his dramas do not keep the stage. His whole works were published in 1770. Simple in manners and shy in disposition, he acquired the friendly favour of Frederick the Great, who found him "quite a different sort of man from Gottsched"—"the most reasonable of all German literary men." Of him we give the following example:—

Wie fang ich's an, um mich empor zu schwingen
Fragt einst ein Jüngling einen Greis
Der Mittel fing er an, um es recht hoch zu bringen
Sind zwei bis drei, so viel ich weiss
Sei tapfer! Mancher ist gestiegen
Weil er entschlossen in Gefahr
Ein Feind von Ruh und vom Vergnügen
Und durstig nach der Ehre war.
Sei weise, Sohn! dem Niedrigsten auf Erden
Ist's oft durch Witz und durch Verstand geglückt,
Am Hofe gross, in der Stadt zu werden;
Zu beiden macht man sich durch Zeit und Fleiss geschickt
Dies sind die Mittel grosser Seelen
Doch sind sie schwer; ich will dir's nicht Verhehlen
Ich habe leichtere mittel gehofft
Gut! Spracht' der Greis, wollt ihr ein leicht'res Wählen
So seid ein Narr; auch Narren steigen oft.

Johann W. Gleim (1719–1803), by goodness of heart and pleasantness of manner won the name of "Vater" Gleim. This very good effervescent creature became canon of Halberstadt, and wrote many fables, epistles, and epigrams, although he devoted his efforts mainly to didactic poems. Of these "Halladat," or "Das Rothe Band" is the foremost in value. It treats, in the first section, of God and his claims to reverential worship, and in the second part on the mutual duties of men. The patriotic ardour with which he sounded the war-note of the Great Frederick's age in his "Preussische Kriegsleider eines Grenadiers" was then unrivalled in thrilling effect. Gleim was the originator of a literary club at Halberstadt, among whose members were Johann P. Uz (1720–96), who modelled his style on Horace.

J. Gotthold Ephraim Lessing (1729–1781) originated a finer form of mellifluous prose and produced a more distinctly vernacular Saxon poetry than had been common in Germany. He agreed with Klopstock, the elder Schlegels, Nicolai, Mendelssohn, and many others that German should take a native form and receive a national culture. Born at Camenz, a clergyman's son, a student of theology, he found in dramatic writing an outlet for his skill in letters and his mental powers. He disliked the soulless, artificial mannerisms which were prevalent, and being a profound philologist he proceeded with indefatigable zeal, as antiquary, historian, fabulist, dramatist, art critic, and poet, with wondrous versatility, depth of thought, and soundness of learning, to replenish the minds of his countrymen with works of all kinds distinguished for purity of style, wit, wisdom, and geniality such as Germany had never before in similar variety been provided with. Lessing was in philosophy a Leibnitzian, with a *soupçon* of Spinozism to give it a mystical relish. His "Erziehung des Menschengeschlechts" has been most effective in turning men's minds to consider the true end of mental discipline. He preferred the active search for truth as a vital exertion of faculty to the gift of the actual and assured possession of it passively received and employed; thought, thinking, willing, and creating are identical in God. He points out that the first period of human history is one in which, like a child, the race looks for immediate enjoyment; the second, when love of fame, honour, and future good move men; and the third, that in which the sense of duty becomes paramount. By him both the critical and the rational philosophy of Germany were stirred. Following Lillo as a prose playwright, he produced "Miss Sara Sampson," adopted the story of Virginia in his fine "Emilie Galotti," at Breslau, under military influence, produced "Minna von Barnhelm," and crowned his dramatic fame by his unmatched "Nathan der Weise." In what Goethe called "the splendid thought" of the Laokoon he "illuminated as by a lightning flash" the whole relations of art, imagination, æsthetics, and poetry. Lessing, with the serene brave dignity of a thinker, having resolved that Europe should be compelled to recognize Germany as an integrant force among its races, went on, like Frederick in politics, restlessly and resistlessly to the struggle which taught the Teutons self-respecting independence of thought and expression, and was, indeed, as Carlyle says, "a writer of books which have turned out to have truth in them," and to have had a singularly stimulating effect on men and events.

In this original development of German literature Lessing had as a coadjutor his friend Moses Mendelssohn, "the Jewish Socrates" (1729–86), who taught that religion was designed to regulate practice, and that the belief in the being of God and the immortality of the soul had not only a foundation in faith and reason, but exerted a reformatory effect on personal

life. The true ideal of religion is not conformity in, but freedom of belief. In the faculty of approval, we have the link between intelligence and aspiration. His "Phædon" is eclectic in the finest sense. Johann Caspar Lavater (1741–1801) was not only the inventor of physiognomy, "the art to find the mind's construction in the face," of which King Duncan had doubts, though Lady Macbeth looked on it "as a book where men may read strange matters;" but also a poet of the people whose Schweizerlieder caught the heart, and whose "Jesus Messias" may be read even after Klopstock. He was endowed with mystic mesmeric power, but, while rebuking some soldiers for unruly conduct in Zürich, was shot by a French grenadier. Lavater and Johann G. von Zimmermann (1728–1795), author of "Ueber die Einsamkeit," once "famed all over the world," were regarded as the Coryphæi of German literature in Frederick's time. The hypochondriac discourser "On Solitude" was a physician "of fine graceful intellect, high proud feelings, and tender sensibilities," with "an immense conceit of himself, and generally too thin a skin for the world." He was an adept flatterer and greedy of official titles and decorations. His other works were on "Experience in Medicine," "National Pride," the "Biography of Haller," a poem on the earthquake at Lisbon, and many essays. He was the subject of a mental malady at last, but he averred "I have lived the life of a man who is desirous to live even after his death."

Johann G. Herder was born at Mohrungen, 26th August, 1744. His father was an assistant schoolmaster, and neither circumstances nor educational advantages were in his favour. By the kindness of a clergyman, Trescho, he got the use of books and lessons in Greek and Latin with his sons. A Russian surgeon took him to Königsberg, where he became intimate with and an admirer of Kant and his speculations. He was made teacher of philosophy and Latin in Frederick's College. In 1765 he got the headmastership of a school in Riga, with a preachership annexed. Herder having studied Lessing and Winckelmann, went over to Eclecticism. He subsequently travelled through France and Italy with the Prince of Holstein-Culm. At Strasburg he formed a friendship with Goethe, who gained for him the appointment of court preacher at Weimar. Here Herder, honoured, popular, and useful, lived, and died 18th December, 1803. His masterpiece is his work on the "Philosophy of History." He had the sympathetic gift of identifying himself with the spirit and character of other nations, and hence the value of his essay on the "Spirit of Hebrew Poetry," and the geniality and attractiveness of his "Voices of the People, or Popular Ballads of Many Nations" (1778), in which Scandinavian legends, Spanish ballads, Hindu fables, Scottish songs, receive such a reproduction as shows loving insight and hearty appreciation. He was less an original thinker than an expositor. Having a rude mass of thought given him he could sculpture it into the most approved national forms, or carve upon it the most delicate tracery of patriotic life. His parables, fables, legends, and traditions are feeble and cold, his "Kritische Wälder" is considerate and striking, "Der Cid"—seventy romances in varying verse and metre, on the fortunes of the Spanish hero—is splendid, and his religious writings show great concern for the spiritual development of the soul. In all points Jean Paul Richter was right: "Herder was no poet, he was something far more sublime and better than a poet; he was himself a poem—an Indo-Greek epic fashioned by one of the purest gods."

In Hood's vivid poem "The Dream of Eugene Aram," the innocent schoolboy of Lynn says, it is "The Death of Abel," and some readers require to have this statement annotated thus:—The reference is to a novel characterized by taste and talent, translated by Mrs. Collyer from the German of Solomon Gesner, and then held in great favour by the religious world. The allusion is slightly anachronistic: Gesner's "Tod Abels" appeared in 1758; "Aram" was executed 1759; Collyer's version appeared in 1761. Gesner's tale has, indeed, rather undeservedly fallen into dimness, but it possesses a quaint charm, and a peculiar interest is imparted in it to the character of Mehala, Cain's wife, and to the manners and sentiments of patriarchal life. The author was born in Zürich, 1730, and died there 1788. He gained distinction as a painter, engraver, poet, and novelist. His "Idyllen" take fair rank among pastoral poems. In "Der Erste Schiffer" Gesner ingeniously attributes to Love the invention of navigation. "Daphnis" was suggested to him by Amyot's oft-reprinted version of Longus, the sophist's love-eclogue. "Evand" and "Erastus" are two dramatic poems, tender and elegant. A sunshiny disposition, graceful wit, and knowledge of the picturesque, appear in "Briefe über die Landschaftsmalerei" (1772).

In the year just mentioned, 1772, a number of literary enthusiasts associated as the Göttinger Poetic Club or Hainbund. Of this Bardenbund, G. A. Bürger (1748) was the chief spirit. The most winning and celebrated poems of Der Volksdichter are his vivid and weird "Leonore" (1775), known if not in many other forms, to everybody in Scott's (1795) "William and Helen;" "Der Wilde Jäger," dashing, daring, and graphic, given in Scott's thin quarto (1796) as "The Chase;" "Die Weiber von Weinsberg," "Das Lied von Braven Manne," "Der Kaiser und der Abt," are all established favourites. His version of Homer is fresh but manneristic. Bürger died a poor poet, 18th June, 1794. Other members of this Hainbund were Johann H. Voss, Ludwig H. C. Hölty, Johann A. Leisewitz, F. W. Götter, the two Counts Stolberg, Cramer, Miller, Wehrs, and others.

The father-in-law of Christoph F. Perthes, one of the most distinguished booksellers in Germany, was also a member of the Göttinger Bardenbund. This was Matthias Claudius (1743-1815), editor of *Der Wandsbecker Bote*, whose "Das Schatzkästelein" is a miscellany of droll, merry, wise, versatile, and *volksthümlich* papers, intended to convey instruction and suasion to the people. He put many popular notions into rhyming verse, and has added to Germany's proverb about travellers' tales, the lines—

"Wenn jemand eine Reise thut
So kann er was erzählen."

Christian F. D. Schubart (1739–91), preacher, orator, author, musician, and journalist, had an ardent ingenious rhetorical intellect. In "Die Deustche Chronik" he advocated freedom so boldly that the duke-regnant of Würtemberg put him in prison (1777), and there during ten years he languished untried. During his captivity he wrote his "Der Ewige Jude," which became suggestive to Shelley, Eugene Sue, and many others. Arnold Ebert (1723-95) was seized with the epidemic Anglomania. Macpherson's "Ossian" and Young's "Night Thoughts," with their magniloquent and rhapsodical phraseology, enraptured him, and he reproduced them, with all their faultiness exaggerated. He did greater service when he introduced the long-drawn-out novels of Richardson to German readers, and made them charm even the psychologic intellect of Kant. Friedrich G. Klopstock (1724-1803), fired by the muse of Milton to enrich German literature with a Christian epic, "rushed in" where angels stand far off in hushed amaze to twang his harp among the mysteries within which the Messiah is enveiled. He began his supernatural song in 1748, and a quarter of a century expired before it was concluded. Menzel calls him the German Homer, and by this poem—which has been translated into English both by G. Egerstorf and by H. H. Milman—as well as by his "Hermanz und Thusnelda," he certainly took a strong hold of the heart of the Teutonic people. He aided greatly in the improvement of German style. Goethe said that "in this matter he was far ahead of his time; but the times were now far ahead of him." We can scarcely recommend the perusal of the whole poem; but several portions will form excellent German studies; *e.g.* the examination of Jesus before the High Priest, IV.; the description of the early Christians, X.; the death of Mary, XII.; the resurrection, XII.; the forty days ending with the ascension, XIX.; as well as the ode "An Dem Erloser," which he wrote on the conclusion of his pleasing and pious toil. It is impossible to doubt that Klopstock's power flashed into the cold thoughts and staid customs of the imaginative people who were being brought under French sceptical influences a surprisingly penetrating light, and that though now we may think his idea of poetry bad, he stimulated the German muse to seek and to sustain freedom from the restraining fetters of French

rhymes and rhythm. The views contained in Klopstock's "Gelehrtenrepublik" (1774), impressed Goethe, influenced Claudius, and affected Voss, while they imparted to the reader a new zest for the poetry of nature.

Wolfgang Menzel characterizes Christoph Martin Wieland (1733–1813) as "a genius overflowing with fascination, jests, dashes of humour, and sallies of wit in inexhaustible measure," and Goethe states that "all Northern Germany is indebted to Wieland for its literary style." He has, indeed, the power of pleasing, his style is easy, graceful, and ornate, his adaptation of phrase to thought is felicitous, and both his industry and versatility are wonderful. He has draped, somewhat stiffly, the dramas of Shakespeare in German, transformed Horace's odes into happy verse, given Cicero's letters and Lucian's dialogues a Germanic form, and imitated Don Quixote exquisitely in "Don Silvio von Rosalva," in which the episode of Prinz Beribinker is highly amusing. His patriotic poem "Arminius" delighted Bodmer, and under that critic's influence he composed "Der Geprüfte Abraham." His attempts at the drama, in "Lady Johanna Gray," "Clementine von Poretta," and "Pandora," a comedy, were not very successful. Five books of an epic on Cyrus (never completed), the beautiful story of "Araspes and Panthea," and the most celebrated of his novels, "Agathon," to which self-portraiture adds zest, were written in Berne. In his native town, Biberach, he composed his poetical "Undine," his story "Komische Erzählungen," "Idris and Zenide," an over-elaborated romantic poem in five cantos; "Musarion," a philosophy of the Graces, and many other works, some of them too loose, florid, and frivolous—too much after the style of the age of Louis XV. After his marriage, and when he had become professor of philosophy at Erfurt, his eroticism was subdued. He quizzed Rousseau in his novel, "Koxhox und Kikequetzel," and in his "Der Goldene Spiegel" he set forth some lessons drawn from history for the rulers of mankind. Called to Weimar as tutor to the sons of the Duchess Amalie he established *Der Deutsche Mercur*, and not long afterwards Goethe, in his farce "Götter, Helden, und Wieland," opposed his views. Through this incident Weimar became the home of Goethe. The best of all Wieland's poetical productions, a worthy German classic, is "Oberon," in twelve cantos. He has not acquired such a predominant power over the German mind as Lessing or Richter, but it must be admitted that he did a great deal to commend the use of the vernacular to the higher classes in German society, and beneficially counterpoised the tendency to transcendentalism which Klopstock and his school introduced into poetic literature.

Johann K. A. Musæus (1735–87) wrote satirical novels and legendary tales, and his Volksmährchen form delightfully entertaining reading. The great name among the early writers of the *familien* romance is that of Johann H. Jung [Stilling] (1740–1817), son of a poor tailor near Nassau, who forsook the needle for the pen, studied medicine, and gained renown as an oculist. His autobiography is so realistic, simple, and true that it is quite a prose idyl. His subsequent religio-mystic novels—*e.g.* "Das Heimweh," "Die Geschichte des Herrn von Morgenthau"—are earnestly pious and fairly interesting. He wrote also occasional verse. August H. J. Lafontaine (1756–1831), a Brunswicker, supplied readers with an immense number of domestic novels. Aug. T. Meissner (1753–1807), a historical novelist, wrote in a polished and ornate style "Masaniello," "Bianca Capello," "Alcibiades", and a good many Skizzen which gratified the public. "Die Reise nach Braunschweig," by Adolf von Krugge (1752–96), is a racy story, rich in humour and practical good sense. T. G. Hippel (1741–96) was, as Kant said, "a writer ready at inventing plots and excellent at working them out." He is pathetic and satiric by turns, and yet quite quiet and unfussy even in his funniest phases. His "Lebenslaüfe" (1778) and "Kreuz und Querzüge" (1783) are carried out with a rare truth to life when dealing with the palpable and the familiar. The effect of the humour of his treatise "Ueber die Ehe" is heightened by knowing that he was a bachelor never ennoosed in wedlock. To him succeeds the sage of Wunsiedel, Johann Paul F. Richter (1763–1825), "Der Einzige." Unsystematic, eccentric, suggestive, acute, with style, thought, pathos, humour all his own, the unborrowed materials of a singular mind which had strange experiences, he has become one of the most celebrated of German writers. He is a philosopher in spite of himself, and whether he reflects, narrates, or describes, poetic imagination, grotesque humour, important thought, and quaint expression issue all at once from the flowing fountains of his strangely endowed mind. What can one tell of his sixty volumes, or how name even the most meritorious of his works, or note the different characters of each? Luckily we may refer our readers to Carlyle's "Essays" for a trustworthy notice of the life, writings, and genius of the hungry glutton of books, poor to foodlessness, unpaid debts, and unsold boots, who struggled on against all miseries in this life into an enduring fame, and through a life on which honour glowed, and comfort, half-ashamed, at last consented to smile—though in his later years bereavement came, physical powers decayed, and blindness darkened the once clear eye. His introduction to "Æsthetics" (1804) and "Levana, a Treatise on Education," are pretty gravely philosophical. His "Kampanerthal," a novel, interprets Kant on Immortality, but "Titan" overflows with inventiveness and strange, weird, wayward humour. "Flegeljahre" (Wild Oats) is shrewd, fresh, distinctive; "Der Komet," "Quintus Fixlein," "Jubelsenior," present far-glancing thoughts, sarcastic humour, and grotesquely sportive fancies. His "Flower, Fruit, and Thorn Pieces," which might form a general title to his entire works, will give the reader a fair idea of his general manner—especially of his exquisite *schwärmerei*. "Hesperus" requires a fluent knowledge of German.

F. von Matthisson was born at Hohendodeleben, near Magdeburg, 1761, educated at Klosterbergen, and studied theology at Halle. He became a teacher at Dessau, travelled as a tutor and as reader to the Princess of Anhalt-Dessau, and resided in Rome and Naples. The King of Würtemberg conferred a diploma of nobility on him in 1809. In 1812 he was installed chief librarian at Stuttgart, where he died in 1831. He edited an elaborate German anthology, and by his own soft, winning, contemplative, and melancholy lyrics of love and friendship won a high place in public regard. Wieland says, "Nature and the Muses have endowed Matthisson with the happiest of all fairy gifts—that of interesting his readers in every circumstance he describes, as well as in every thought, wish, and imagination which arise in his mind;" while Schiller calls him "the apostle of a sterling loveliness of style." His "Elysium" is his masterpiece, but the elegy "Auf den Ruinen eines Bergschlosses" is the most celebrated of his minor verses. His style was modelled on that of Thomas Gray. L. T. Kosegarten (1758–1818) furnished Germany with a spirited version of Gray's "Elegy," composed a pleasing pastoral poem, "Jucunde," wrote idyls and legends, and produced some novels, of which that having the best reputation is "Ida von Plessen." His pathos seems to want reality, and his style is affected. His figures are waxenly fair, but less vital and real than they might have been.

Christopher Aug. Tiedge (1752–1841) develops sublime and profound ideas in pure and elegant forms, having the quality of vitality. His didactic poem, "Urania," though despised by Goethe for formality and abstractness, contains some star-bright verses on God, immortality, human freedom, and religion. His "Frauenspiegel" is commendable, and many of his minor productions—*e.g.* "Der Abend," "Das Echo," "Blumen auf Grab eines Kindes," &c.—are fluent, finished, and notable.

One's early recollections of Baron Münchausen are of thrill, wonderment, and incredulity. There was a German Baron, Adolphus Münchausen, many years privy-councillor of George II. as Elector of Hanover, who, according to Heyne, introduced freedom of thinking, feeling, and writing into the University of Göttingen. But a lieutenant-colonel, Karl R. Münchausen (1729–96), who extemporized his "Abentheuer" to his friends, by whom they were readily printed, probably gave currency to the synonym for "very marvellous stories indeed!" a Münchausenism. Bürger edited several of the strange adventures of the splendid braggart in 1786, but the first collection was made in 1785 by Rudolph Eric Raspe, a German storekeeper in the Dolcoath mines in Cornwall, 1792, who interpolated many tales from Castiglione, Bildermann, Lange, and others. W. F. W. Jacobs (1764–1826), well known

as a philologist, is an extremely able novelist, who wrote in a classical style and infused genuine piety into his interesting and attractive tales, *e.g.* "Rosaliens Nacklass," "Die Feierabende in Meinau," "Die beiden Marien," &c. Ernst F. A. Hoffmann's genius is bizarre and fantastic, but he has the power of bringing delicious anxiety and excitement into the reader's mind by his "Nachstücke," "Sepharionsbruder," &c. Benzel Strenau in his "Das goldene Kalb," "Proteus," "Titania," &c., almost rivals Richter in amusing humour, tact, and power of invention and description, though his style seems quaint rather by awkwardness than by intention. Langbein's ballads, romances, and tales are easy and racy, good-naturedly comic, though sometimes inartistic in their breadth. Among his rhymed pieces "Der Gastfreund," "Die Rossdecke," "Das grosse Loos," were highly popular. Konrad G. Pfeffel (1736–1809), though he early became blind, acquired repute by fables, stories, epigrams, and lyrics. He is humorous, original, and naïve. His drama "Der Schatz" was popular. F. Jacobi (1734–1819), besides being a philosopher who writes with warmth and clearness of Hume, Spinoza, &c., and controverts Kant's idea that "faith supplies no knowledge," is also known as the author of the two philosophical novels "Waldemar" and "Allwill's Briefsammlung" in a shrewd, animated, sagacious style—which his countrymen call Platonic. Heinrich J. Campe (1746–1818), as a charming and instructive writer for the young, has earned the name of "the German Berquin"—for his "Swiss Family Robinson," "Theophron," "Die Entdeckung von America," &c., besides being distinguished as a scholastic, a dialectician, and a philosopher.

It must be remembered that the political divisions of the Germanic States not only localized fame, but contracted the field of appeal and influence. They aroused and quickened rivalries, created coteries, and gave importance to Bunds. The effects of the great pre-revolutionary Aufklärung—with its opposition to faith and hostility to settled opinion, when originality and self-will were seeking influence, and a high sense of the benefits of education was making itself felt in Central Europe—Frederick kept in check, so far as politics went, but he allowed them to work away in the regions of thought, engaged with religion and literature. The intellectual movement that swayed Berlin society had been occasioned by the teaching of Rousseau, Voltaire, and *L'Encyclopédie.* It was Frankish, not Teutonic. All the eminent workers in German literature were more or less solitary—not stirred, possessed, or influenced by any widely extending national interests or political excitements. The German states were petty, and collective life for national ends had not permeated society with common principles resulting in community of thought. There was no outlet in Germany for the efforts of genius, unless in the service, bureaucratic or military, of some of the courts of the jealous states of the numerous princes who held sway over narrow territories. Enlargement of aim and effort was possible only in imagination and in literature. Hence poetry was pursued as a pleasant social occupation, imagination employed its energies in description or adventure, and letters were frittered away on the infinite permutations possible in the utterance of commonplace. Formerly the spirit of the Reformation had exercised an influence arising from common sympathies, but political changes had broken up societies, and religious apathy had crept into the heart. Only in speculation was there a possibility of mental life. Hence the influence exercised by philosophy in Germany, and this explains the eagerness with which metaphysics was pursued, and enables us to comprehend the stir of thought evoked by Kant and his disciples and assailants, and the marvellous effects which have been produced in Germany by the doctrines of Fichte, Hegel, Schelling, &c.

Kant, though he starts from the scepticism of Hume, had not escaped from the sensationalism of Locke and the overmastering rationalizing idealism of Leibnitz, when he undertook the "Critique of Pure Reason." Wolf could systematize and collect the ideas on God, nature, thought, and faith which Leibnitz expressed, but the fine ideal essence of the conceptive unity of man's inner life and its harmony with the outer life of nature and the divine being of the Deity, was incapable of being captured in the network of mere syllogism. It could not be made an examinable class-subject, for that must be possessed by the mind as knowledge, not wisdom. Knowledge is inventive of forms, wisdom is an incentive to look through and beyond, and therefore to disregard forms, if they are mere forms. To Kant philosophy's first duty was criticism; thereafter construction would be possible. No expression of speculative science should contradict human experience. Only, therefore, by critical examination of experience, as seen in the light of reason, could speculation be regulated and the data drawn from facts be rightly related in thought. Kant investigated (1) the *sources* of human knowledge, (2) the *sphere* of the possible in thought, and (3) the *limits* of reason. Consciousness cognizes, memory recognizes, and reason interprets facts. The relative nature and worth of knowledge are determined by the understanding, but the absolute of moral law, of self-legislative freedom, and of the divine existence, become known to and through the reason as truth and duty, beauty and virtue. Hitherto philosophy in Germany had been a thing apart from human life and interests; here it was brought home to men's businesses and bosoms. Kant became the central figure in intellectual Europe. In him, the abstruse recluse, sitting quietly in his Königsberg study, an example of simplicity in thought and naturalness in life, Germany found its hero—the *one* who united the race in idea, feeling, and aspiration; for here was a distinctly German thing, which struck Europe and commanded Teuton sympathy—a philosophy which, being at once a reasoned statement of the rights and duties, the functions, privileges, and position of man in the universe, included in its favourable regards the rights of nations as proclaimed by the American War, of individuals as advocated by the revolutionists of France, of education as urged by Rousseau, and yet was true to the German monarchy and to the Reformation, to the state and the church, to individual man, and to the Divine Lawgiver in nature, nations, and conscience. Kant first really rationalized and nationalized the thought of Germany.

ENGLISH GRAMMAR AND COMPOSITION.

CHAPTER XIV.

PARAGRAPHING—THE CHIEF QUALITIES OF STYLE—THE PRINCIPAL KINDS OF COMPOSITION.

Words are combined into sentences, sentences into paragraphs, and paragraphs may either be arranged in sequence, or be divided into sections, chapters, or other divisions of the kind of composition in which the writer or speaker is engaged. The syntax of a sentence may be rigid, and when the requirements of grammatical order are strictly enforced the sentence is said to be periodic; but when the language is less closely knit the sentence is said to be loose. In familiar speech, simple narrative, and on ordinary occasions, considerable looseness in structure is permitted; but well-compacted periods are requisite in dignified literary composition.

Sentences are usually built up into paragraphs. A connected series of sentences closely related to one another, referring to the same subject, and all tending towards the communication of one particular phase of a subject, constitute a paragraph. Every paragraph ought to take up one specific and particular topic, should set that forth plainly, fully, and with such a variety and attractiveness as shall secure its being understood. Hence unity of purpose should rule over it, and from beginning to end not only continuity of idea, but progress in unfolding or explaining it should be made. Paragraphs should each possess a certain degree of completeness, and when they are properly arranged there ought to be no returning to the expression of the same specific point again, unless a fresh aspect of it is to be presented or in a summarizing paragraph, where the various portions of the matter of discourse are to be brought together into one view. The qualities of paragraphs are distinctness, connectedness, coadaptation, and completeness in regard to the point taken and the view urged. The style of a paragraph should vary with the purpose and place it holds in the general plan. Introductory paragraphs should be plain yet interesting, progressive paragraphs ought to be well arranged, and concluding paragraphs should be impressive.

Judiciousness in the method of arrangement, in the allocation of space, and in the interweaving of the whole so as to be as far as possible a fitting adjustment of part to part, and of each part to the whole, are matters of great importance in paragraphing.

By syntax the art of combining words into sentences has been explained, but it is seldom that a single sentence suffices for the whole function of communication. Periods of varying form, extent, relation, and connection are employed to bring our thoughts into distinct orderly sequence and fullness of exposition.

The words and members which constitute a period ought to be so arranged as to secure syntactical completeness and accuracy; or in more specific terms, adjectives, relative pronouns, participles, adverbs, and explanatory clauses should be placed as near as possible to the words to which they relate, and in such positions as shall make their reference quite apparent; nouns and pronouns should in general be placed immediately before or after the verbs with which they are connected; prepositions should always precede the nouns they govern; and conjunctions ought to stand between those words or clauses which they are intended to conjoin. Abrupt, short, smart, oracular, and laconic sentences must not appear too frequently in composition; for although they may appear energetic, they are destitute of the dignity, beauty, and clearness which belong to the carefully constructed though lengthy period, while by not placing the whole object and its accompaniments at one view before us, but elevating each item of relation into the dignity of an independent subject, we break the unity of aspect which it ought to possess. They do not present the picture in a group, but bring before us in succession the individual figures which are intended to form a group.

Variety of expression and of arrangement of words in a sentence is a great aid to the securing of attention, and often the transposition of words, if not too forced and violent, has the effect of arousing the listless and gaining fresh regard. It is an excellent exercise, which we commend to all anxious to write well, to try how frequently (1) the form of a sentence may be changed, and (2) the words employed in it may be varied, still retaining the same meaning; and it is interesting to notice that the difference in acceptance to the ear and of impression on the mind is sometimes made by very slight variations in the position of words or in the phrases used.

There are two pre-requisites to the attainment of a good style of composition—(1) a complete and accurate knowledge of the language in which we speak or write, and a ready practical mastery of it; and (2) logical precision of thought. Accurate thought expressed in exact words is always effective, and pleasing effectiveness is the characteristic of choice expression. Effectiveness is essential; winningness and grace are highly commendable. We speak that we may pass thought from mind to mind, and like all social acts men are gratified when thought is communicated pleasantly.

All the most essential qualities of style, so far as regards the structure and arrangement of sentences, may be said to be these seven:—Perspicuity, conciseness, unity, strength, vivacity, harmony, and appropriateness.

1. "*Perspicuity*," says Quintilian, "should be the chief excellence of style—proper words, an accurate arrangement, a period not drawn out in length; nothing either wanting or superfluous." In his "Thoughts concerning Reading and Study," Locke states that "perspicuity consists in the using of proper terms for the ideas or thoughts which we would have pass from our own minds into those of other men. It is this that gives them an easy entrance; and it is with delight that men hearken to those whom they easily understand. Whereas what is obscurely said, dying as it is spoken, is usually not only lost, but creates a prejudice in the hearer, as if he that spoke knew not what he said, or was afraid to have it understood." If we suppose the possession of clear thoughts by a speaker or writer, then a proper choice and collocation of words should secure the perspicuity of his sentences. It is true, however, as Archbishop Whately says, "that perspicuity is a relative term, and consequently cannot be predicated of any work without a tacit reference to the class of readers or hearers for whom it is designed; and that it is not inconsistent with ornament and conciseness." Both these facts ought to be kept distinctly in view in composition and in judging of it.

Plain thoughts ought to be uttered plainly; abstruse truths can only be stated in language adequate to their expression. But provided the meaning of the words used is known, that composition is perspicuous in which the precise ideas intended to be conveyed are clearly presented to the mind by the language employed. In a perspicuous sentence the words used are translucent, and the meaning is immediately discernible. Perspicuity is opposed to ambiguity and obscurity, and the law regarding it is, that a composition should be such, not that a man may understand if he will try, but that he shall understand without the trouble of trying, and indeed whether he will or not.

2. *Conciseness* is that quality of style in which all superfluity of words is avoided, and the ideas intended are exhibited with distinctness, brevity, and force. It does not countermand elegance or ornament, although it requires a skilful employment of clear, powerful, and compressed diction. To follow out a course of thought with strict logical consistency, to proportion the expressions employed to the real importance of our ideas, to give definiteness and compactness to what we say, and thus to place before the mind the thought, the whole thought, and nothing but the thought, so that it shall be clearly and distinctly understood, are the chief excellences of composition; and if these purposes be kept in view and steadily acted upon, a concise style must be the result;

> "For when our minds with clear conceptions glow,
> The willing words in just expression flow."

The general rules for concise composition are—(1) Avoid the use of superfluous words and phrases; (2) be content when a thought is clearly expressed; and (3) aim at acquiring such a command of language as shall enable you to get the right word in its right place at the right time.

3. *Unity* is that characteristic of style which places an idea before the mind clearly marked off from all others, free from unnecessary words, and so connectedly and completely embodied as to leave no part unexpressed. It gives an integrity and oneness to the conceptions expressed. Unity of style can only result from unity of thought, the capacity of taking a thorough grasp of our ideas, and a habitual striving after the attainment of continuity and fixedness of thinking. No composition can be concise without being perspicuous, nor perspicuous without being concise; in like manner, perspicuity and conciseness almost secure unity, while unity as necessarily concurs in promoting a clear, brief, and pointed expression of thought.

4. *Strength* is the power of influencing others at will. Words are peculiarly effective in enabling us to move, excite, and persuade men. Strength supposes language to be animated with an earnest purpose, and words to be so selected and disposed that they present our ideas with the greatest possible force to the minds of those whom we wish to move. To write strongly be precise, concise, specific, and put every word in proper order.

5. *Vivacity* is the conjoint result of a combination of many excellences, such as novelty, uncommonness, contrast, geniality, and sprightliness of language. These give a smack to composition which makes the reader relish and admire it. Novelty is always delightful; the strange excites and attracts; anything opposed to the routine or use and wont of life rouses lively interest and quickens reception.

6. *Harmony* depends upon the choice and arrangement of words. It refers to those melodious cadences which give agreeability to style. Some combinations of letters and words are more easily pronounced than others. Words of agreeable tone are in general more gratifying to the ear than those of harsh sound or more difficult articulation. True harmony does not, however, result from the adoption of the most musical expressions we can find, but in the choice and fitting arrangement of those successions of syllables and words which possess the greatest possible relative melody; that is, such as are most nearly indicative of the feelings which ought to be originated by the thoughts we utter. There seems to be a

natural felicity of expression which suits so exactly with the general strain of a thought that no contrast between the ideas and the expression is ever felt. This is an excellence worth diligent labour to acquire. The intimate connection which exists between ideas and language makes the necessity for attention to harmony obvious. Discourse, to be attractive, must be pleasing. Not the most melodious sounds, but those most consonant to the subject of writing or speech, constitute harmony—such as comports with

> "Painting in sound the forms of joy or woe,
> Until the mind's eye sees them melt and glow."

7. *Appropriateness.*—This might rather be regarded as the one word in which all the qualities of style might be expressed than as a single specific characteristic. Perspicuity is always appropriate, and yet one may sometimes employ a harmonious instead of a harsh word, though the latter may be a plainer term. It is not essential to be blunt and disagreeable in order to be thoroughly understood. Conciseness is praiseworthy, but to be over-laconic may sometimes defeat the very purpose for which conciseness is recommended—readiness of being understood. The reception of new ideas is not always made easier by expounding them either in proverbs or in epigrams. Unity of view may frequently be made more palpable by a contrast than by a mere exposition. Strength is most valuable, but minds are not always most certainly taken by storm, and even strength may be gentle and used gently. Vivacity is pleasant, but it need not degenerate into jocularity or horse-play, and not unfrequently a little gravity may even add to the attractiveness of the arch and gleeful. Harmony is delightful, but we may err by lapping a subject in soft Lydian measures which requires to be made striking and stirring rather than lulling. Exhortation must not be made so sweet and low as to induce sleepiness. There is a suitability of speech to a subject which, when used, makes its exposition effect the object of the speaker. Everybody feels that there are men who uniformly impress their hearers with the idea that the manner in which they have expressed a thought is the best possible, and make it seem as if in no form else could it be put more effectively. These have attained the secret of appropriateness. Their words fit not like a glove only, but like the skin itself, and give the idea that they are in reality the very happiest external vesture in which their thoughts could be put. Appropriate sentences may well be characterized as "the fruit of the lips"—full and ripe, delicious and attractive, giving a pleasure in its substance which is enhanced by its form, and suggesting that both have grown together—thought assimilating the most apt phrase, and the phrase adapting itself to every requirement of the thought. This is the highest quality of style—the *bouquet* of speech.

No single style is suitable for all purposes, and no one's style can be commended as that to be invariably imitated. Macaulay's "Lays" could not be written in Goldsmith's verse; Addison's pellucid prose would be an unsuitable medium for Carlyle's "French Revolution;" Newman's sinuous ease would be inappropriate to Mill's placid sensationalism; and the style of Whewell's "Philosophy of the Inductive Sciences" would not be beneficially exchanged for De Quincey's vagrant versatility. Scott's "Ivanhoe" would lose by translation into the style of "Esmond," and "Vanity Fair" could ill brook the epistolary diffuseness of "Sir Charles Grandison." A "Paradise Lost" in the verse of Pope's "Messiah," Cowper's "Boadicea" in the rhythm of "The Burial of Sir John Moore," or Gray's "Elegy" in the hexameters of Longfellow's "Evangeline" would impress with a sense of inappropriateness. To have a good style is to express every thought in the form best adapted to impress, interest, and gratify while communicating all that is wished. To be distinguished for *a* style is not to be distinguished for style. The best style is translucent, and exhibits what is required without calling for remark upon itself. It is the transmitter of the light of thought.

To show that a variety of style is essential, we need only notice that the matters to be expressed are of different characters, and that the objects men have in view in speaking differ. The various kinds of compositions may be classed under one or other of the four following heads, or some combination of them—1, Narrative or Descriptive; 2, Didactic or Preceptive; 3, Argumentative; and 4, Persuasive.

1. *Narrative* or *Descriptive Compositions* give an account of some event or events, and of the persons concerned in them, the places in which they occurred, or the objects among which they took place. They include (1) histories—natural, sacred, civil, literary, including antiquities, laws, customs, arts, &c.; (2) biographies, including epistolary correspondence; (3) novels and other fictitious narratives, as tale, legend, apologue, parable, fable, &c.; (4) voyages and travels. They refer (1) to external objects; (2) to internal processes; (3) to the action and reaction of these two, *i.e.* extraordinary events; (4) to the actors in these events. These ought, in general, to be exhibited in the order, first, of time; secondly, of place; thirdly, of suggestion; and fourthly, of causation.

2. *Didactic* or *Preceptive Compositions* are those in which instruction is conveyed, such as expositions of the sciences and arts, treatises on etiquette, methods of study, &c.

3. *Argumentative Compositions* contain regular trains of reasoning, of principles and facts already known and established, or accepted and assumed as known and certain, such as shall lead to the demonstration of the truth or utility of some propositions hitherto undetermined, or the ascertaining of some fact hitherto unknown. Of such a nature are philosophical treatises, critical essays, imaginary dialogues, dissertations, pleadings, speeches, &c.

4. *Persuasive Compositions* are those which have the excitement of the emotional nature of man as their chief aim—such as are intended to excite affection, desire, or passion—action directed by certain motives to a given end. Passion is the mover to action—reason the guide. Good is the object of the will; truth that of the understanding. It is only through the passions, affections, and sentiments of the heart that the will is to be reached. It is not less necessary, therefore, in the orator, to awaken those affections in the hearers which can be made to co-operate most easily with his view, than it is to satisfy their understandings that the conduct to which he would persuade them tends to the gratification of the affections raised. But though both are really intended by the speaker, it is the last only that is formally presented to them as entering into his plan. To express a formed purpose to work upon men's passions would be like giving them warning to be upon their guard. To apportion the due amount of persuasion requisite to produce a given action or course of action, with the proper sentiments from which such action or course of action should result, requires great good sense and careful self-management.

GEOLOGY.—CHAPTER XIV.

THE CAINOZOIC ERAS: EOCENE, MIOCENE, AND PLIOCENE—THE QUATERNARY PERIOD: PLEISTOCENE, HISTORIC, AND PREHISTORIC.

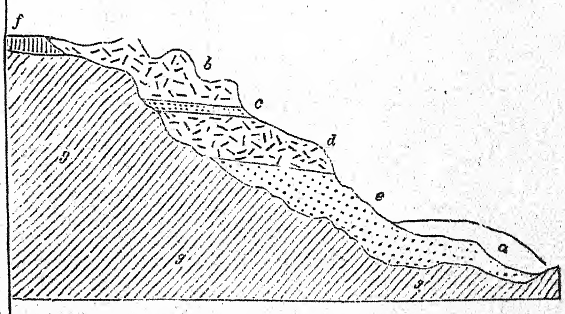
In the panorama of physiography, of which, for far more than a century, geologists have been sedulously gathering sketches for us from every accessible portion of the solid globe, we have now reached the Tertiary period, to which—in order that it might indicate the nearness of the forms of life which it revealed to those occurring in our own era—John Phillips proposed that the name *Cainozoic* (Gr. *kainos*, recent; and *zoe*, life) should be given. In the Tertiary series of formations the types of life which their fossils show are modern—that is, are similar to those found in the present day. To the period comprising the older Tertiary series—that is, the period in which the genera and species of organized living things closely resembling those with which we are familiar now have their earliest representatives—Sir Charles Lyell gave the name *Eocene* (Gr. *eos*, the dawn, and *kainos*), the dawn of recent life. The Middle series, owing to their comparatively less remoteness from our own time, and their nearer approximation in variety of type to the living forms of the present, receive the name of *Miocene* (Gr. *meion*, less), while the more recent or younger series, for a similar reason, are designated *Pliocene* (Gr. *pleion*, more). This classification and these technical terms (with some modifications) hold their place in the litera-

ture of geological science as at once convenient and suggestive; but it has been by recent scientists, at the suggestion of Beyrich, agreed to introduce between the Eocene and Miocene periods the *Oligocene* (Gr. *oligos*, little), to denote the early Tertiary deposits lying between the Upper Eocene and the Lower Miocene subdivisions. The ground of the classification suggested by Lyell was percentage of fossil forms similar to Neozoic plants and animals—Eocene ranging from 3 to 10 per cent., Miocene from 10 to 35, and Pliocene in two subdivisions—(1) old, from 35 to 50, and (2) new, from 50 to 95, while in the Post-pliocene or recent period the percentage reached from 95 to 100.

In England, between the Upper Chalk of the Cretaceous system (see p. 1209) and the overlying Thanet Sand, which forms the base of the Lower Eocene London basin, we have no ascertained knowledge of the facts of the intervening period. The top of the Chalk shows signs of extensive denudation between the time when it was deposited and the sedimentary formations or Cainozoic beds which mark the next geological epoch. But though here the chronicle of the interval seems to have been erased, some evidence of the occurrences which marked the intervening ages survives in the West of Europe in the Maestricht Chalk (see p. 1210), in the Upper members of the Senonian system at Faxo, in Zealand, in the pisolitic limestone of the Paris basin, &c., in the North American developments of the Tertiary formations lying along the borders of the Atlantic Ocean, and on the western seaboard of Oregon and California. It has been stated as probable that a Tertiary flora was contemporaneous with a Cretaceous fauna in the North American series. Though there occurs between the Cretaceous rocks and the Cainozoic deposits which lie uncomformably upon them, the most considerable break in geologic time as yet apparent, the North American series of conformable beds suggest that further research may yet reveal the means of filling up this *lacuna* in the recorded eras of the globe's history.

1. *Eocene.*—The strata of the Eocene rocks of Britain, when grouped in relation to the physical changes they suggest, may be regarded as exhibited in the small and detached (known) areas they occupy in a threefold classification: (1) a series of beds laid down in shallow fresh, sea, or estuarine water on a denuded surface of chalk; (2) a central group laid down where the waters had deepened and the sea had widened its inroads; and (3) an upper series deposited where the sea had retreated and rivers and lacustrine fresh water possessed the area. The Lower series contains three members: (1) the Thanet Sandbeds, which show a thin layer of flints at the base, and consist of a (sometimes clayey) pale yellow or greenish sand, in which are found about seventy known species—almost all marine—of fish, gasteropods, lamellibranchs, foraminifers, &c. (2) The Woolwich and Reading deposits, which are estuarine sheets of (lenticular) plastic clay, loam, sand, and pebbles. The species contained in these exceed 100, including those of landgrowing plants. The *Ostrea Bellovacina* lies in a thick bed at the base, and *Ostrea tenera* is numerous. The organic remains of sharks, turtles, and crocodiles are found, and the bones of a mammalian called Coryphodon, of the tapir kind. (3) The Oldhaven beds, which though thin, are peculiarly fossiliferous. Among their gravel and pebbles 150 species have been observed. The shells are marine and estuarine; gasteropods abound; the fig, the cinnamon, and conifers have been traced. Very recently, too, in the Lower Eocene beds near Croydon, a gigantic bird, allied to the goose, and similar in kind to those found at Meudon in France, has been discovered and described. The Middle series exhibit three marine groups: (1) the London clay, a stiff brown or bluish-gray mass, with lumps of gray limestone septaria in it. It has its equivalent in the Bognor series, and is well seen at Alum and Whitecliff Bays; and near Newberry, in Essex, it is typically represented. The Isle of Sheppy is a happy hunting-ground for its fossils. Its layers suggest deposition close to the outlet of a large river like the Ganges or the Amazon, in an estuary or shallow sea. The marine mollusca are abundant. Reptiles show many species—turtles, tortoises, crocodiles, sea-snakes, &c. Crustaceans are numerous and crabs are found. Of fish—a saw-fish, a sword-fish, rays, and sharks may be noted. Birds of the vulture and kingfisher kind existed then, and of mammals we may mention the opossum, several tapirs, a kind of hog, and a bat. The seeds, fruits, &c., of legumes, conifers, laurels, juniper, &c., obtained in it show that tropical conditions prevailed. (2) The Bagshot sands and clays in Surrey are comparatively unfossiliferous, but in the Hampshire basin, where they are well exhibited, as at Bournemouth and in the Isle of Wight, there are found among their strata most of the fossils regarded as typical in the nummulitic limestone of the Mediterranean basin, where the Eocene rocks have been traced from the Pyrenees through the Alps and the Carpathians into the Balkans, the mountains of Greece, from both of which they pass into Persia, India, and China. The Lower Bagshot beds are of light coloured sand, the Middle beds (*i.e.* the Bracklesham and Burton clay), are put by the Geological Survey among these, though Lyell inserted them in the Upper series. They find their equivalent in the *Calcaire grossier* of Paris. But, especially in the Tertiary system, geological terms are employed with some latitude—not with absolute, but only with relative strictness, and rather for convenience than with distinct finality. Here there occurs Beyrich's suggested Oligocene, and Continental geologists insist on other modifications of British nomenclature. The Headon, Osborne, and Hempstead beds, consisting of sands, clays, marls, and limestones in thin alternated strata, exhibiting a fluvio-marine accumulation, are regarded as forming this series. The Palæotherium (a three-toed tapir-like creature), the Anoplotherium (a two-toed half-hog, half-deer), the Cœnopithecus (an early lemur), the Architherium (the progenitorial type of the horse), and Deinocerata (rhinoceros-like creatures as huge as elephants), were among the animals of this period. There is a sort of Australian-like aspect in the scenery and forms—animal, vegetable, and marine—of the Eocene period, though its later flora is somewhat American.

2. *Miocene* is a term used for a series of strata of more recent date than the Eocene. They are scarcely traceable in the British Isles. Between the granite of Dartmoor and the Greensand Hills at Bovey Tracey, in Devonshire, a series of sand, clay, and lignite beds occur, which seem to be the deposits of a Miocene lake of the same era as the lower Miocenes of Switzerland. By the fossil plants here and there found between the sheets of basalt which give magnificence to the coast of Antrim and the Western and Faroe Islands—attaining their maximum development in Mull—the geological date of the volcanic eruptions by which they were formed may be approximately fixed as belonging to the older Miocene period of the lacustrine deposits of Switzerland and the plant-beds of North Greenland. During these Miocene times the enormous corrugations of the Alpine ranges were thrown up. Across Belgium and North Germany, as well as across the Fahlun districts of Sweden, the Miocene seas seem to have flowed, sunk into shallowness, and then formed lagoons, morasses, and lake-basins in which successive series of shelly layers have been deposited; while a wide area in the north-west of Europe appears to have been exposed to the strong and varied forces of volcanic activity. Of Miocene formations the Righi and Rossberg are instances. The annexed diagram



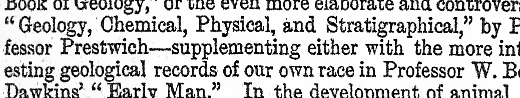
Section of the Miocene slopes of Mount Perrier, in Auvergne.

a New alluvium. *b* Second Trachyte Breccia. *c* Second Miocene Alluvium, with bones. *d* First Trachyte Breccia. *e* First Miocene Alluvium. *f* Compact basalt. *g* Eocene limestone strata.

will, better than words, convey an idea of the manner in which the Miocene sedimentary deposits have been interstratified and disturbed by volcanic eruptions. The Molasses of the geologists of Switzerland are regarded as of Upper Miocene date. They consist of clays, sands, marls, limestones, brown-coal, and lignite seams, in which are preserved many of the plants that occupied the highlands, many of the insects which flitted among the woodlands of Œningen, and a large number of shells like those of tropical seas in the Helvetic range, and of the lake-like brackish water in the Tongria districts. Dr. Heer, by indefatigable labour, has explored all these environs, and has compared and classified the plants of these deposits, with the result that he finds American types more frequent than European ones, and that they decrease in ratio in the following order—Asia, Africa, and Australia. In the silt of these lake-basins are remains of the deer, tapir, rhinoceros, mastodon, as well as of strange ruminants now extinct, while upwards of thirty species of fish, crocodiles, and chelonians cognate with existing genera are known to have tenanted the waters. The plants, leaves, flowers, and fruits have been preserved with such singular delicacy that the changes and succession of the seasons can be traced by the vegetable remains.

The many difficulties of arrangement and interpretation arising in regard to the Miocene period—as to extent of geographical range, and of stratigraphical distribution, modes of deposition, causes of interruption and displacement, as well as the solution of the crux of the climatology of this middle era—can only be explained by lengthy and intricate details and discussions, necessitating criticisms of principles which would be out of place in such a simple form of geological exposition as falls to us. The interest felt in them will give a charm to the perusal of books like those of A. J. Jukes-Brown, on "Historical Geology," in which "Hantonian" and "Icenian" phenomena are placed in a fresh light, and prepare the student for the zestful use of Dr. Geikie's "Class-Book of Geology," or the even more elaborate and controversial "Geology, Chemical, Physical, and Stratigraphical," by Professor Prestwich—supplementing either with the more interesting geological records of our own race in Professor W. Boyd Dawkins' "Early Man." In the development of animal life as it proceeded throughout the whole of the Tertiary period, the forms approach more nearly to those of living species the higher we rise in the scale of strata, and the same fact is observable in the vegetable kingdom.

3. *Pliocene* strata exhibit a comparatively small development in Britain. The entire series, with the exception of a deposit of no great extent discovered near St. Erth, in Cornwall, is confined to the counties of Norfolk, Suffolk, and Essex. In this late division of the Tertiary period Britain seems to have been part of the European mainland, and to have been—except by the rising of a number of basalt-dykes in the cracks of the crust of Northern England and Scotland—little affected by the upheavals of the Alpine area and the eastern parts of the Continent. When subsidence occurred in the hollow of the North Sea, the surface of the south-eastern counties mentioned was submerged and overlaid with thin sheets of gravel and sand deposited in the shallow waters of the coast-line. The nature and relative positions of the stratification are illustrated in the accompanying diagram. These old marine shell-banks are usually



divided into the three following groups:—(1) *Coralline Crag*, so called, not from their containing true corals, for only four kinds of these are found, but from the coral-like Polyzoa or Bryozoa which abound in it, and of which 140 species have been recognized. Fish of the whiting, cod, and pollack species are found among its sands and marls. It is only developed in Suffolk, and gets the names of Suffolk, White, and Bryozoan Crag. At the base of this crag (so-called) "coprolite beds" supply the phosphatic manures of Felixstowe. (2) *Red Crag*—beds of quartzose sands and gravel of a dark-red or brown ferruginous colour, of which the deposition appears to have been disturbed by confusing currents running in shallow water. The fossils have a northern character. Though they consist chiefly of Mollusca, yet organic remains of skates, sharks, and true whales have been obtained. Out of twenty-five species of corals fourteen are identical with those of the present day. At Walton-on-Naze the *Trophon antiquum* ("reversed whelk") is remarkably distributed. (3) *Norwich Crag*, a fluvio-marine of shelly sand and gravel, sometimes—from the large number of bones of extinct mammals, chiefly elephants, obtained from it—called *Mammaliferous Crag*. The hippopotamus, otter, beaver, horse, deer, and mastodon have also been recovered from the area of marine deposits, typically developed, near Norwich, where it rests upon the washed and worn surface of the Chalk formation.

On the banks of the Scheldt, and near Antwerp, Pliocene deposits have been examined, and two-thirds of their fossils are reckoned identical with those in Suffolk. On the coast of Normandy similar strata occur. Central France contains similar strata. In Val d'Arno mammaliferous deposits have been unearthed, and the seven hills of Rome consist of Pliocene strata. The strata which feather off from the slopes of the Apennines to the seas engirding Italy, and those which form the hills of Sicily, even at a height of 3000 feet, exhibit similar remains. On the shores of the Black Sea, the Sea of Azof, the Sea of Aral, and the Caspian, estuarine beds, deposited in brackish water, are assigned to the same period. Near the Attic village of Pikermi, Professor Gaudry of Paris has disentombed many remains of the huge mammals of the marine strata of the Pliocene era—*e.g.* the Machærodus, a sabre-toothed tiger, the Hipparion, a three-toed horse, giraffe-like animals, huge elephants, large antelopes, hyænas, monkeys, and other extinct quadrupeds. The Siwalik Hills, southward of the Himalayas, in India, hold immured in their sandstones and clays numerous fossil remains of vertebrate animals primitively Pliocene. A form resembling an American alligator has been discovered. Crocodiles and gharials of many more species than those now native to the district have been examined; an enormous tortoise (*Colossochelys atlas*), 8 feet long, is notable among all the Chelonian reptiles; pigs and pig-like creatures are numerous, and the Sivatherium, an enormous ruminant carrying four remarkable horns, has been found among the fossil bones examined and described by the Indian governmental Geological Survey.

4. The Chillesford and Westleton shelly sands and clay occur as thin local deposits of the newer Pliocene period, and may be regarded as the terminal phenomena of it. The fossils which have been recovered from these east-coast beds—two-thirds of which are similar to those that live in arctic waters—indicate a southward movement of the severe climate of boreal regions, and seem to foreshadow that lowering of the temperature of Europe which ultimately ushered in the glacial age of the Quaternary period. This thermal change must have brought other great changes in its train, for both animal and vegetable life are singularly subject to the elements.

It is difficult to collate the evidence of age from beds presenting different lithological characters, occurring in such distinct localities, and having tracings of their interrelations erased by subsequent changes. This can only be done by accepting some such principle as Lyell proposed—of arrangement by percentages of approximation shown in the fossils of the rocks of the past to the forms and developments of life in the historical era of the present period, and by an ideal superposition of rock on rock in a graded nearness to the phenomena of our own time. Without being able to posit or suppose a uniform operation of the same causes in like circumstances, at the same period, in any given age in the past, this collation and superposition are environed with difficulties, and perhaps for these and similar reasons it has not been found easy to group the European series of the Tertiary strata alongside of their American Cainozoic equivalents. The Lower Eocene of Europe is usually regarded as having for its western coeval the lignitic strata of America—in which the vegetable remains are of anthracite or bituminous coal, but many of whose deposits have assumed the character of palæozoic slate, and are, in California, even crys-

talline in their constitution. Great differences of opinion therefore exist on the subject. The Alabama group are ranged with the Middle and Upper Eocenes of Europe, because in their two sub-groups, Clayborne and Vicksburg, fossils are obtained, many generically, some specifically, similar to the mammalian, marsupial, and tapiroid animals of European Eocenes. Though its fauna is found to be richer, and in it has been found the Orohippus—an early form of horse about the size of a fox—the strata of sand and clay which stretches over a wide extent of the eastern seaward states, known as the *Yorktown series*, are yoked beside the Miocene groups, because the organic remains contained in them not only supply similar forms to those which occur in the Middle Tertiaries, but intermediate types which fill up gaps between species. The Sumter strata contain the series of mammalian types of the lower layers, and investigators like Marsh and Leidy have been able to bring up from the hollows of the older Tertiary formations marine shells resembling Pliocene species, besides adding to our knowledge of palæontological life proofs of the existence of three species of camel now extinct; a species of Merechyus—compounding the forms of camel, deer, and hog; five species of the horse, as well as a number of species of herbivorous and carnivorous animals allied to species now extinct. They all, however, have the peculiarity of being very distinctly Oriental in their forms and relations.

Quaternary, Post-Tertiary, or Neozoic geology is usually considered under two heads: (1) *Pleistocene* (Gr. *Pleistos*, most), most recent, an old group of deposits in which many species of extinct Mammalia occur — sometimes designated *Diluvial;* and (2) *Recent* or *Historic*, a later series of strata in which the Mammalia are all of species still extant—sometimes designated *Alluvial.* The prime fact of the Pleistocene period is the appearance of early man—appearing (1) in the drift along with the remains of animals of the temperate era, and known as *river-drift man*, and (2) in caves, along with remains of animals of arctic habit, and known as *cave man.* The second is that a remarkable climatic change, from the comparative warmth of the Pliocene period to the intense cold of the Pleistocene glacial era, occurred. The third is that of seventy-eight species of land mammalia then extant, fifty-five continue to hold a place among the species now occupying the world. In the Early Pleistocene age—which the preglacial forest-bed series and other fluviatile strata, typically exhibited at the base of the cliffs of Norfolk and Suffolk, represent—there appear arctic, temperate, and southern animals, and twenty-seven species of Pliocene creatures survive; from the Mid-Pleistocene age all the Pliocenic survivals—except the *Rhinoceros megarhinus*—have ceased, although type-animals of north temperate and southern climates remain. The lower brick-earths of the fluviatile deposits of the Thames valley—at Crayford, Erith, Ilford, &c.—are of Mid-Pleistocene date. The flint knives found in the Brixham caverns may be regarded as belonging to this era. In the river gravels and bone-caves of the later Pleistocene era all Pliocenes are gone, animals suited to southern climates are present, but even as far as the northern Alps and the Pyrenees remains of arctic species abound. In cavern-loam at lake bottoms, in peat-mosses under sand-dunes, in river drift, and other forms of accumulated *debris*—"the ruins of an earlier world"—the history of early man is to be traced.

The order of the Pleistocene strata is not well known. The phenomena, rather than the contents of their deposits, excite the interest of the modern geologist, and lend a charm to research regarding them. Britain then appears to have formed the western highlands of Europe, and Northern Africa was joined to Europe. The islands of the Mediterranean and the Archipelago were mountains. The British Islands and north of Europe, as far south as Saxony, must have been ice-covered like the interior of Greenland at the present time—the Alps and the Apennines being sheeted with snowfields, from which glaciers descended, eroding and removing the deposits on the land surface in their course. The grinding action of this land-ice must have been enormous, and its influence, even on the solid rock, has been marked. Oscillating variations of temperature must have occurred, and hence the local differences in the nature and succession of the deposits observed. These may be classed as accumulations of the following sorts:—(1) Preglacial—marine and fresh water; (2) glacial—marine and terrestrial, including moraines, boulder clay or till, the fine muddy *loess* of the Rhine and the Danube, the *kaims* of Scotland, the *eskers* of Ireland, &c.; and (3) post-glacial, when the ice-age softened, and the raised sea-beaches were left behind, while in other cases forests were submerged, caves filled up, and peat-mosses formed. The phenomena of "earth sculpture" have been most fascinatingly dealt with by modern geologists, *e.g.* Dr. A. Geikie and Sir A. C. Ramsay, under both of whom, as directors-general of the Geological Survey, drift-maps have been produced, showing the superficial deposits of the hills, mountains, valleys, and plains of the British Isles.

Remembering that the rock-pages of the autobiography of the globe have only been opened to us here and there, and in a few places only, we can peruse, as it were, only excerpts of its progressive life, and even these we are frequently unable to decipher without the aid of the analogies of historic geology. The careful survey of the surface of the earth—its mountains and hills, crags and peaks, cliffs and bluffs, its valleys and plains, ravines and passes, its river-courses, ocean-basins, and lake-beds, its wrinkled ridges of corrie and dale, gully and outcrop, its flats and swamps, and all the appearances of its superficial features—furnishes the analogies, suggestions, and facts which form the intellectual key to the meaning of the (incompletely known) past of geologic evolution. These prove to us that two series of forces have been engaged in changing the phenomena of landscape contour, (1) interior, and (2) exterior. We have endeavoured to present some account of the phenomena occasioned by inner heat and motion, and of outward sedimentation, denudation, by erosion and abrasive sculpture, and to show how the knowledge of these enables us to form some idea of that stratigraphical geology which reconstructs for us (ideally) the palæontological past. In the sketches thus given we have aimed at exhibiting the views entertained by the best authorities on each period, era, and age, and to present these in the least dogmatic form they could assume in regard to disputed theories and controversial points. These can only be rightly dealt with by experts in science. The student's first duty is to know, not to discuss. When full information has been acquired, and the scientific interpretation of facts comes into the scope of study and acquisition, he will reason on what he knows all the better that he has little to unlearn, and has not been taught to contemn opinions as unsound before he was able to weigh the worth of all the evidence available to those who enter on research with zeal according to knowledge. The lexicon of the science, the facts on which it founds, and the interpretations which have been given, have been explained in brief. He can now pursue the course of speculation, carrying in his thoughts at once some knowledge of phenomena and some acquaintance with the ideas by which it has been sought to give the consistent systematic unity of science to geology.

The prehistoric formations, when distinguished from the Pleistocene, are referred to that epoch in which Britain was isolated from Europe, and the continents assumed something nearly approaching their present contour. Its most marked features is the extinction of river-drift and cave man, and the introduction of Neolithic man, the successive passage through (1) the stone age, (2) the bronze age, and (3) the iron age—according to the material of the tools he employed. Geology includes the history of man in the larger chronicle of the events of the globe on which he dwells. But when the psychozoic age of intelligent man is reached, archæology claims the privilege of detailing all that can be learned of his progress from the earlier stages of his being till civilization crowns his life, and history takes up the recording pen to register his doings and misdoings, his progress, and the transitions of his social and political life. Man's shaping imagination gathers around it the phenomena of fact, and frames it fitly together into poetry, industry, commerce, science, art and letters, religion, statesmanship, and philosophy. The Geological Survey, organized in 1830 by Sir H. T. De la Beche, and adopted by the Ordnance Survey as a branch in 1834,

became a subdivision of the Science and Art Department in 1854. Under successive directors-general, and with its official staff, it has not only done good service itself, but taken a leading place among the "National Surveys" of the world. It has recently resolved to issue from time to time a series of monographs by experts on each of the special formations. These, it is certain, will be full of facts, carefully stated and arranged, and will co-ordinate in their proper places all the phenomena to which they relate with accurate reference to the principles of the science, because the authors will have ready access to the most authentic statements, and possess the fullest information. The several geological societies established in so many of the leading towns in Britain, headed by the Geological Association—whose president, Mr. Rudler, in November, 1887, ably sketched "Fifty Years Progress in British Geology"—and stimulated by the triennial meetings of the International Geological Congress, afford many opportunities of pursuing studies connected with the history, phenomena, and curiosities of man's dwelling-place. We commend to all students whose curiosity and interest have been awakened by these chapters, to take a personal part in the practical work of geological investigation, and whether engaged in pursuits connected with the subject, or only observers of what is seen in quarry, mine, brickfield, or landscape, to employ to the utmost the faculties of observation and thought in the acquisition of that knowledge which is not only power but often profit, and always pleasure.

ALGEBRA.—CHAPTER XIII.

INVOLUTION AND EVOLUTION OF NUMBERS AND QUANTITIES —SQUARE AND CUBE ROOT.

A NUMBER which is multiplied once, twice, thrice [or any greater number of times] by itself is said to be raised or involved to the *second* (square), *third* (cube) [or any greater number of times its] *power; e.g.* $13 \times 13 = 169$, its second power or square; $13 \times 13 \times 13 = 2197$, its third power or cube. Inversely, any number which on being divided once, twice [or any greater number of times] by itself produces a definite number as its result is a root; *e.g.* $169 \div 13 = 13$, the square root; and $2197 \div 13 \div 13 = 13$, the cube root.

A careful examination of the following table of numbers and their powers will amply suffice to show the student the meaning of what has been said:—

Powers.	1	2	3	4	5	6	7	8	9	10
2nd (square) .	1	4	9	16	25	36	49	64	81	100
3rd (cube) . .	1	8	27	64	125	216	343	512	729	1,000
4th (Biquadrate)	1	16	81	256	625	1,296	2,401	4,096	6,561	10,000
5th	1	32	243	1,024	3,125	7,776	16,807	32,768	59,049	100,000
6th	1	64	729	4,096	15,625	46,656	117,649	262,144	531,441	1,000,000
7th	1	128	2,187	16,384	78,125	279,936	823,543	2,097,152	4,782,967	10,000,000
8th	1	256	6,561	65,536	390,625	1,679,616	5,764,801	16,777,216	43,046,721	100,000,000
9th	1	512	19,683	262,144	1,953,125	10,077,696	40,353,607	134,217,728	387,420,289	1,000,000,000
10th	1	1024	59,049	1,048,576	9,765,625	60,466,176	282,475,249	1,073,741,824	3,486,784,411	10,000,000,000

Involution is the operation of multiplying any number by itself one or more times, exemplified in the preceding table (which may be indefinitely extended). The products so obtained are called the powers of the number; the number itself is called the *root* of these powers; the root is said to be its own *first power*. *Evolution*, or the Extraction of Roots, is the process of calculating the root of a given power. Evolution bears the same sort of analogy to division, that involution bears to multiplication.

The *second power* (*i.e.* the root or first power multiplied by itself) is called the *square*. If two square figures are such that the side of the larger contains the side of the smaller a given number of times, the second power of that number expresses the number of times that the area of the larger square contains the area of the smaller; *e.g.* if the side of the larger square be 4 times the length of the side of the smaller, the area of the larger square will be $4 \times 4 = 16$ times the area of the smaller.

The *third power* (*i.e.* the second power multiplied by the first power) is called the *cube*. If two cubical figures are such that the edge of the larger contains the edge of the smaller a given number of times, the third power of that number expresses the number of times that the volume of the larger cube contains the volume of the smaller cube; *e.g.* if the edge of the larger cube be 4 times the length of the edge of the smaller cube, the volume of the larger cube will be $4 \times 4 \times 4 = 16 \times 4 = 64$ times the volume of the smaller.

The *fourth power* is the third power multiplied by the first; the *fifth power* is the fourth power multiplied by the first, and so on, as has been exemplified in the foregoing table.

The number expressing the order of a power is called its *index*, and sometimes its *exponent*. It is customary to express a given power of a given number by writing (1) the given number or root, and then (2) expressing the exponent by a small figure written at the upper right-hand corner of the figure or figures denoting the root; as,

4^2 is an abbreviation for 4×4, or the second power of 4;
4^3 " " for $4 \times 4 \times 4$, or the third " 4;

and so on, as seen in the table.

The annexed sign $\sqrt{}$ (really a survival of the letter *r* of *radix*, a root) is used to express the root of a number; as, $\sqrt[2]{}$, $\sqrt[3]{}$, $\sqrt[4]{}$, &c., express the square, cube, fourth, &c., root of any given number. This is sometimes also indicated by using a fractional index; as, $36^{\frac{1}{2}}$ means the square root of 36; $\sqrt[4]{48}$ and $48^{\frac{1}{4}}$ alike express the fourth root of 48, and $\sqrt[8]{12^5}$ or $12^{\frac{5}{8}}$ represents the eighth root of the fifth power of 12.

The general properties of powers and roots are most easily explained by the aid of arithmetical examples; still, as the use of algebraical principles and notation greatly facilitates that explanation, we shall endeavour to give a combined view of this subject available for the information alike of students of arithmetic or algebra.

By examining the table of powers—and extending it where necessary—the student will be able to verify for himself these statements as to square roots—viz. (1) every square of one or two figures has only one figure in its root; (2) every square of three or four figures has only two figures in its root; (3) every square of five or six figures has only three figures in its root; (4) every square of seven or eight figures has only four figures, and so on; as, $\sqrt[2]{944784} = 972$, and $\sqrt[2]{30858025} = 5555$. As to cube roots—viz. (1) every cube of one to three figures has only one figure in its root; (2) from four to six, two figures; (3) from seven to nine, three figures; (4) from ten to twelve, four figures, and so on; as, $\sqrt[3]{918330048} = 972$, and $\sqrt[3]{171416328875} = 5555$. These we may now generalize:—

1. *The square of a number expressed by a given number of digits contains either double that number of digits, or double that number less one.*

2. *The cube of a number expressed by a given number of digits contains either treble that number of digits, or treble that number less one, or treble that number less two.*

3. *The square, cube, or any other power of a number which is the product of two or more factors, is the product of the squares, cubes, or other corresponding powers of those factors.*

Square.

$$30^2 = 30 \times 30 = 2 \times 3 \times 5 \times 2 \times 3 \times 5;$$
$$= 2 \times 2 \times 3 \times 3 \times 5 \times 5;$$
$$= 2^2 \times 3^2 \times 5^2.$$

Cube.

$$30^3 = 30 \times 30 \times 30 = 2 \times 3 \times 5 \times 2 \times 3 \times 5 \times 2 \times 3 \times 5;$$
$$= 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 5 \times 5 \times 5;$$
$$= 2^3 \times 3^3 \times 5^3.$$

4. *The powers of an even number are all even; those of an odd number are all odd.*

If a given root be exactly divisible by a certain number, every power of that root will be exactly divisible by the corresponding power of that divisor, and by every lower power. For example, 12 being exactly divisible by 3, it follows that 12 is exactly divisible by 3^2 and by 3, that 12^3 is exactly divisible by 3^3, 3^2, and 3, and so on.

Before extracting the square root of a number it is divided into periods of two figures each, beginning at the unit's place, above which a point is placed, and one on each alternate figure from right to left. The number of the points show the number of figures in the root; as $\sqrt[2]{1\dot{0}0\dot{0}45\dot{6}9}$, indicating that it has a four-figured root—viz. 3163. In a similar way, before extracting the cube root of a number, its figures are divided by points into periods of three, beginning at the unit's place; as, $\sqrt[3]{\dot{1}02\dot{4}19\dot{2}51\dot{2}}$, indicating a four-figured root—viz. 1008.

What we have now learned enables us to see (1) that 1 is the integer part of the square root of all numbers from one to four; (2) that a fraction is found in the root of every number that is not a perfect square: *e.g.* the square root of 2 or of 3 is 1 with a fraction; (3) that the square root of a number which is not a perfect square is the root of the preceding perfect square plus some fractional part: *e.g.* the square of 20 is 4 and a fraction, and that of 90 is 9 and a fraction. If our readers will turn to page 1198 they will see, under Proposition IV., a geometrical proof of what has been said, and they will comprehend better what follows—viz. every number of two (or more) figures may be divided into two quantities, as $27=20+7$; $424=420+4$. If we represent the first part by a and the second part by b, then $a+b$ will represent all numbers of two or more figures, and the squaring of $a+b$ will represent the operations; as,

$$
\begin{array}{lcccr}
a+b & & 20+4 & & 24 \\
a+b & & 20+4 & & 24 \\
\hline
a^2+ab & \text{or} & 400+80 & \text{or} & 96 \\
\quad +ab+b^2 & & \quad 80+16 & & 48 \\
\hline
a^2+2ab+b^2 & & 400+160+16=576 & & 576
\end{array}
$$

This shows that the square of a number of two or more figures contains (1) the square of the first part, *i.e.* $a^2=400$; (2) twice the product of the first part by the second, *i.e.* $2ab=160$; and (3) the square of the second part, *i.e.* $b^2=16$.

If now we are asked to extract (1) the square root of $a^2+2ab+b^2$, we have first to discover the quantity a. Subtracting the square of a from the given quantity, we have $2ab+b^2$ as our remainder. That we may discover the quantity b, it is obvious we must double the part (a) already obtained, and place it as the divisor of this remainder, adding, however, in order to complete it, the quantity b itself; then multiplying this divisor by b, we have the quantity $2ab+b^2$, which is to be subtracted from the remainder. And if (2) the square root of 576 be required, it is plain that it will be the inverse of this operation, as in A, which, however, is practically abbreviated in B.

4×20	4^2
20×20	4×20

A.

$$
\begin{array}{rl}
 & \sqrt[2]{\dot{5}7\dot{6}}=20[\textit{i.e. } a]+4\,[\textit{i.e. } b] \\
 & 400=a^2 \\
2a=40 & 176=2\times a\times b+b^2 \\
 & 160=2\times a\times b \\
 & 16=b^2 \\
 & 16=b_2
\end{array}
$$

B.

$$
\begin{array}{rl}
 & \dot{5}7\dot{6}(24 \\
 & 4=a^2 \\
44) & 176 \\
 & 176
\end{array}
$$

The cube root is found in a similar manner.

Since the square of $a+b$ is, as we have seen, $a_2+2ab+b^2$, the multiplication of that square by $a+b$ will produce the cube of $a+b$, thus—

$$
\begin{array}{rl}
 & a^2+2ab+b^2 \\
 & a\ +b \\
\hline
 & a^3+2a^2b+ab^2 \\
 & \quad +a^2b\ +2ab^2+b^3 \\
\hline
 & a^3+3a^2b+3ab^2+b^3 \\
\hline
(a+b)^3= & a^3+3a^2b+3ab^2+b^3
\end{array}
$$

On examining this process we see that the cube of a number of many figures contains (1) the cube of the first part [*i.e.* a^3], (2) + three times the product of the square of the first part by the second [*i.e.* $3\times a^2\times b$], (3) + three times the product of the first part by the square of the second [*i.e.* $3\times a\times b^2$], and (4) the cube of the second part [*i.e.* b^3]. By cubing 35 in the same way, the same results will be seen to arise; as,

$$
\begin{array}{l}
30+5 \\
30+5 \\
\hline
30\times30+5\times30 \\
+5\times30+5\times5 \\
\hline
30\times30\times2\times5\times30+5\times5\ [\textit{i.e.}\text{ the square}].
\end{array}
$$

Multiplying the result by $30+5$, we get

$$
\begin{array}{c}
30\times30+2\times5\times30+5\times5 \\
30+5 \\
\hline
30\times80\times30+2\times5\times30\times30+5\times5\times30 \\
+30\times30\times5+2\times5\times30\times5+5\times5\times5 \\
\hline
30\times30\times30+3\times5\times30\times30 \\
+3\times30\times5\times5+5\times5\times5 \\
30^3+3\times5\times30^2+3\times30\times5^2+5^3.
\end{array}
$$

The foregoing explanations should enable the student to follow out and understand the working contained in the examples given in the next page.

We had better, however, premise a few hints regarding the mode of proceeding practically with the calculations involved.

When the required root of a given number is not already known by memory or by the use of tables, it must be found by a process of trial. That process is conducted so as to get the figures of the root successively one after another, beginning at the left or highest denomination. The first figure is always known by inspection, by memory, or by tables; that figure is raised to the given power, and the result subtracted from the given number, leaving a remainder. The second figure is usually found by trial, its correctness being tested by computing the increment which it produces in the power; that increment should not exceed the remainder already computed, and should not be so much less than that remainder as to show that the new figure of the root ought to have been greater. Subtracting the increment from the remainder, a second and smaller remainder is or may be left; and each successive figure of the root is found by trial in the same way until no remainder is left (which is always the case ultimately, if the given number is an exact power), or until a remainder is left so small as to be unimportant for practical purposes (which is always the case when the given number is not an exact power).

When the number whose square root is sought is not a perfect square, there will be a remainder after all the periods of the number itself are brought down, and the root will be only approximate. An approximation to any degree of nearness that may be required is obtained by annexing periods to the remainder, each consisting of a pair of naughts (00), one such period being annexed for each additional digit required in the root, and carrying on the operation as before; but some remainder will always be left, no matter how far it may be carried, as is seen in example 2 (next page).

The process for an integer and that for a decimal fraction are exactly alike, except in the placing of the decimal point.

Extraction of Square Root.—(1) Required the square root of 14665·21.

		Given power.	Root.
		1,46,65·21	(121·1
Square of first figure,		1	
1st divisor,	22	0,46	First remainder.
Increment of root,	2	44	Increment of power.
2nd divisor,	241	2,65	Second remainder.
Increment of root,	1	2,41	Increment of power.
3rd divisor,	242·1	24·21	Third remainder.
Increment of root,	·1	24·21	Increment of power.
Twice the root,	242·2	0	Remainder exhausted.

(2) Required, the approximate value of $\sqrt{1000}$ to four places of decimals.

		Given Number.	Approximate Root.
		10,00	(31·6227.
Square of first figure,	9		
1st divisor,	61	1,00	First remainder.
Increment of root,	1	61	Increment of power.
2nd divisor,	626	39·00	Second remainder.
Increment of root,	6	37·56	Increment of power.
3rd divisor,	6322	1·44,00	Third remainder.
Increment of root,	2	1·26,44	Increment of power.
4th divisor,	63242	17,56,00	Fourth remainder.
Increment of root,	2	12,64,84	Increment of power.
5th divisor,	632447	4,91,16,00	Fifth remainder.
Increment of root,	7	4,42,71,29	Increment of power
Twice approx. root,	632454	48,44,71	Sixth remainder.

The exact square, of which 31·6227 is the root, is 999·99515529, differing from 1000 by the last remainder ·00484471. By annexing pairs of naughts and continuing the process, any required number of additional decimals may be computed.

$$
\begin{array}{ll}
\text{(i.)} & a^2+b^2+c_2+2ab+2ac+2bc\,(a+b+c \\
 & a^2 \\ \hline
2a+b) & b^2+c^2+2ab+2ac+2bc \\
 & b^2 \quad +2ab \\ \hline
2a+2b+c) & c^2+2ac+2bc \\
 & c^2\times 2ac+2bc
\end{array}
$$

$$
\begin{array}{ll}
\text{(ii.)} & a^2+2ab+2ac+b^2+2bc+c^2(a+b+c \\
 & a^2 \\ \hline
2a+b) & 2ab+2ac+b^2+2bc+c^2 \\
 & 2ab \quad +b^2 \\ \hline
2a+2b+c) & 2ac+2bc+c^2 \\
 & 2ac+2bc+c^2 \\ \hline
\end{array}
$$

Extraction of the Cube Root.—This process is analogous to the extraction of the square root, but more complex. It will be best understood by the following example:—

Example 1.

			Given Power.	Cube Root.
1st trial divisor,	$3\times10^2=300$		1,775,956,931	(12·11
	$3\times\ 10\times\ 2=$	60	1	Cube of 1st fig. of root.
	$2^2=$	4		
			775	1st remainder.
1st complete divisor,		364	$\times2=728$	Increment of cube.
			47·956	2nd remainder.
	$3\times\ 10\times\ 2$	60		
	$2\times\ 2^2$	8		
2nd trial divisor,		43200		
	$3\times\ 120\times\ 1$	360		
	1^2	1		
2nd complete divisor,		43561	$\times1=43561$	Increment of cube.
			4395,931	3rd rem'nd'r.
	$3\times\ 120\times\ 1$	360		
	$2\times\ 1^2$	2		
3rd trial divisor,		4392300		
	$2\times1210\times\ 1$	3630		
	1^2	1		
3rd complete divisor,		4395931	$\times1=4395,931$	Incre. of cube.

The given power being exhausted there is no remainder.

(3) Required, the cube root of $a^3+3a^2b+3ab^2+b^3$.

$$
\begin{array}{ll}
 & a^3+3a^2b+3ab^2+b^3\,(a+b \\
 & a^3 \\ \hline
3a^2+3ab+b^2) & 3a^2b+3ab^2+b \\
 & 3a^2b+3ab^2+b^3 \\ \hline
\end{array}
$$

(4) Required, the cube root of $x^3+12x^2+48x+64$.

$$
\begin{array}{ll}
 & x_3+12x^2+48x+64\,(x+4 \\
 & x^3 \\ \hline
3x^2+12x+16) & 12x^2+48x+64 \\
 & 12x^2+48x+64 \\ \hline
\end{array}
$$

In the foregoing example the number whose cube root is required is a perfect cube; and the process of evolution comes, as we have seen, to an end by the exhaustion of the power. But if the given number is not an exact cube the remainder is never exhausted; and the cube root can only be found approximately by carrying on the process until a sufficient number of figures have been computed for the purpose in view. After the significant figures have all been brought down the process is continued by annexing naughts in sets of three (000) at a time to the remainder.

Required, the cube root of 100 to four places of decimals.

Example 2.

			Given Number.	Approximate Cube Root.
1st trial divisor,	$3\times40^2=$	4800	100	(4.6415.
	$3\times\ 40\times\ 6=$	720	64	Cube of 1st fig. root
	$6^2=$	36		
1st complete divisor,		5556	36,000	1st remainder.
			$\times6=$ 33,336	Incre. of cube.
	$3\times\ 40\times\ 6=$	720	2,664,000	2nd rem'der.
	$2\times\ 6^2=$	72		
2nd trial divisor,		634800		
	$3\times\ 460\times\ 4=$	5520		
	$4^2=$	16		
2nd complete divisor,		640336	$\times4=$ 2,561,344	Incre. of cube.
			102,656,000	3rd remaind'r.
	$3\times\ 460\times\ 4=$	5520		
	$2\times\ 4^2=$	32		
3rd trial divisor,		64588800		
	$3\times4640\times\ 1=$	13920		
	$1^2=$	1		
3rd complete divisor,		64602721	$\times1=$ 64,602,721	Incr. of cube.
			38,053,279,000	4th remaind'r.
	$3\times4640\times\ 1=$	13920		
	$2\times\ 1^2=$	2		
4th trial divisor,		6461664300		
	$3\times46410\times\ 5=$	696150		
	$5^2=$	25		
4th complete divisor,		6462360475	$\times5=$ 32,311,802,375	Increment of cube.
			5,741,476,625	5th remaind'r

The exact cube, of which 4·6415 is the root, is

$$100-0·005,741,476,625=99·994,258,523,375.$$

From the largeness of the remainder, if the calculations had been carried out the next figure would have been 8, and 4·6416 would have been a closer approximation, but as the precise cube of 4·6416 is 100·000,721,719,296, it is somewhat over the mark.

By the use of tables of calculation higher cubes may be

employed, and this considerably lightens the labour. We give a simple case in example:—

$$
\begin{array}{rcrl}
 & & \dot{1}75\dot{4}36\dot{0}8 & |\ 259 \\
25\times25\times25 & = & 15625 & \quad 1875 \\
187500 & & & \\
3\times250\times9 = \quad 6750 & & 19186{,}08 & \\
9\times9 = \quad 81 & & & \\
\hline
194331\times9 & = & 1748979 & \\
 & & 169629 & \text{Remainder.}
\end{array}
$$

Here 25 is taken as a cube at once, and its result is subtracted from the given power; next taking 1875 for a trial division of the sum taken down—leaving off the two last figures (*i.e.* those on the right)—this gives 9 as a quotient, with which we proceed to deal thus:—187500 is 300 times the square of 25; 3 times 250 multiplied by 250, and that multiplied by the units figure in the root, give 6750; then 9 squared gives 81. These several sums being added together and their total being multiplied by 9, the units figure of the root, give 1748979, and this subtracted from the previous remainder leaves 169629 as the final remainder, unless it is desired to carry the answer out into decimal places, which the student may readily do, as in the foregoing example 2.

(5) Given $8x^3-36x^2y+54xy^2-27y^2$, to find its cube root.

$$
\begin{array}{ll}
 & 8x^3-36x^2y+54xy^2-27y^3(2x-3y \\
12x^2 & 8x^3 \\
\hline
-18y+9y^2 & -36x^2y+54xy^2-27y^3 \\
\hline
12x^2-18xy+9y^2 & 36x^2y+54xy^2-27y^3
\end{array}
$$

The sixth root of an algebraic expression may sometimes be found by taking the cube root of its square root, or the square root of its cube root.

The following generalized statements may now be regarded as within the grasp of the sudent, with the means of following them out in theory and employing them in practice:— By a root of any quantity is meant the inverse of a power of that quantity. Hence, if p be a power of r, then r is the root of p. The following table will render the relative meaning of the terms familiar, and it may be verified by the numerical table previously given.

Name of r.		Conditions fulfilled.
Square of	r	$p = rr$ . . . . . or r^2
Cube of	r	$p = rrr$ . . . . . or r^3
Fourth power of . . .	r	$p = rrrr$ . . . . . or r^4
Fifth power of	r	$p = rrrrr$ . . . . or r^5

Name of p.		Conditions fulfilled.
Square root of	p	rr . . . . . or $r^2 = p$
Cube root of	p	rrr . . . . . or $r^3 = p$
Fourth root of	p	$rrrr$ . . . . . or $r^4 = p$
Fifth root of	p	$rrrrr$ . . . . or $r^5 = p$

And so on.

To multiply together any two powers of the same letter, we make the exponent of the product the sum of the exponents of the factors.

EXAMPLES.

$x^2\times x^3=x^5$. $\quad x^4\times x^3=x^7$.

$ax^3\times x^5=ax^8$. $\quad abx^7\times x^2y^2=abx^9y^2$.

The rule also applies when there are more than two factors; for

$$x^2\times x^3\times x^5\times x^4=(x^2\times x^3)\times(x^5\times x^4)=x^5\times x^9=x^{14}.$$
$$7a^2b^6\times3a^2b^2c^3\times7a^4x\times3b^3x^2\times5cx^2y^3=2205a^8b^{11}c^4x^5y^3.$$

Let it be required to divide a^7 by a^3. Since $7=4+3$, or since $a^7=a^4\times a^3$; therefore $a^7\div a^3$ or $\frac{a^7}{a^3}$ is a^{7-3} or a^4. Hence we see that

To divide the power of a quantity by another power of the same quantity (of a less exponent) we must subtract the exponent of the divisor from the exponent of the dividend.

EXAMPLES.

$a^5\div a^2=a$. $\quad a^7\div a^6=a^1$ or a.

$10a^7\div5a^4=2a^3$. $\quad 7x^2\div14x=\frac{1}{2}x$

$\frac{24a^6b^4c^4d^2}{4a^4b^2c^3d}=6a^2b^2cd$. $\quad \frac{3a^2p^3q^4x^2z^3}{6ap^2q_2xz_2}=\frac{1}{2}apq^2xz$.

To raise a power of a monomial (*i.e.* an expression or quantity consisting of a single term, as x) *to any given power, multiply the exponent of the proposed quantity* (x) *by the exponent of the proposed power:* the result is the exponent; *e.g.* The fourth power of x^2 is $x^{2\times4}=x^8$, for $(x^2)^4=x^2\times x^2\times x^2\times x^2$.

$$(x^3)^2=x^6. \quad (x^2)^5=x^{10}. \quad (x^4)^5=x^{20}. \quad (x^4)=x^8.$$
$$(x^2)^n=x^{2+2+2\text{ \&c. to } n \text{ terms}}=x^{2n}. \quad (x^m)^n=x^{mn}.$$

A power of a product is the product of the factors severally raised to the power proposed; as,

$$(xyz)^3=xyz.xyz.xyz=xxxyyyzzz=x^3y^3z^3$$
$$(x^2y^3z^4)^3=x^2x^2x^2y^3y^3y^3z^4z^4z^4=(x^2)^3(y^3)^3(z^4)^3=x^6y^9z^{12}$$
$$(x^my^nz^p)^r=(x^m)^r(y^n)^r(z^p)^r=x^{mr}y^{nr}z^{pr}$$
$$\left(\frac{x}{y}\right)^3=\frac{x^3}{y^3} \text{ for } \left(\frac{x}{y}\right)^3=\frac{xxx}{yyy} \text{ and } \frac{x^3}{y^3}=\frac{xxx}{yyy}$$
$$\left(\frac{a^2b^4}{xy^3}\right)^2=\frac{a^4b^8}{x^2y^6} \qquad \left(\frac{ab^2c^3}{a^3y^2z}\right)^4=\frac{a^4b^8c^{12}}{x^{12}y^8z^4}$$

(The same rule may be applied to fractional quantities, though into this we cannot enter).

The extraction of roots being denoted arithmetically by the radical sign $\surd$, its use is shown in the following table:—

The 2nd root of x is $\sqrt{x}$, of x^2 is $\sqrt{x^2}$, of $\sqrt{x}$ is $\sqrt{\sqrt{x}}$

The 3rd root of x is $\sqrt[3]{x}$, of x^4 is $\sqrt[3]{x^4}$, of $\sqrt{x^2}$ is $\sqrt[3]{\sqrt{x^2}}$

The 4th root of x is $\sqrt[4]{x}$, of x^3 is $\sqrt[4]{x^3}$, of $\sqrt[2]{x}$ is $\sqrt[4]{\sqrt[2]{x}}$

The 5th root of x is $\sqrt[5]{x}$, of x^m is $\sqrt[5]{x^m}$, of $\sqrt[n]{x}$ is $\sqrt[5]{\sqrt[n]{x}}$

and so on: observing that $\sqrt{x}$ means $\sqrt[2]{x}$, the index 2 being usually omitted.

To extract a root of a power of any monomial (as x), *divide the exponent of the power by the index of the root, if that division can be effected without introducing fractions.*

If there be a numerical coefficient, its root must, of course, be extracted, as in common arithmetic; for example—

$$\sqrt{16x^4y^2}=4x^2y. \quad \sqrt[4]{81a^{12}b^4c^8}=3a^3bc^2.$$
$$\sqrt[3]{343a^3x^6y^6z^{12}}=7ax^3y^2z^4. \quad \sqrt[5]{32a^{10}x^5y^{15}}=2a^2xy^3.$$

The root of a root has the product of the indices of these roots for its index.

The root of a product is equal to the product of the roots of the factors.

Carrying with him the knowledge of and power over algebraic expressions and operations conveyed in the foregoing lessons, the capable student should now be able to pursue the science of symbolic notation into its higher reaches with interest and ease. We hope he will not regard algebra as a mere practical art, but as an intellectual logic and a science of the operations involved in calculation.

For of algebra now, even more than when Dr. Barrow uttered the words, we may truly say: "The steps are guided by no lamp more clearly through the dark mazes of nature, by no thread more surely through the infinite turnings of the labyrinth of philosophy (*i.e.* science), nor, lastly, is the bottom of truth sounded more happily by any other line. I will not mention with how plentiful a stock of knowledge the mind is furnished from these studies, with what wholesome food it is nourished, and what sincere pleasure it enjoys. But if I speak further, I shall neither be the only person nor the first who affirms it—that while the mind, abstracted and elevated from sensible matter, distinctly views pure forms, conceives the beauty of ideas, and investigates the harmony of propositions, the manners themselves are insensibly corrected and improved, the affections composed and rectified, the fancy calmed and settled, and the understanding raised and excited to more divine contemplations; all of which I might defend by the authority and confirm by the suffrages of the greatest philosophers."

SOLAR SPECTRUM AND SPECTRA OF PROMINENCES, CORONA, NEBULA, COMETS &c.

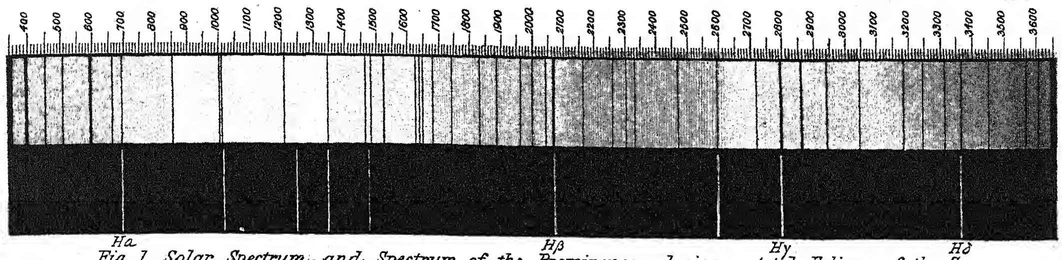


Fig. 1. Solar Spectrum, and Spectrum of the Prominences, during a total Eclipse of the Sun.

Fig. 2. Spectrum of the Corona.

Fig. 3. Spectrum of the Aurora Borealis.

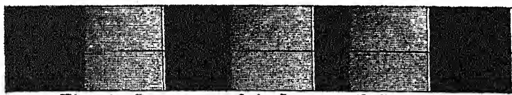


Fig. 4. Spectrum of Carbon in Olefiant Gas.

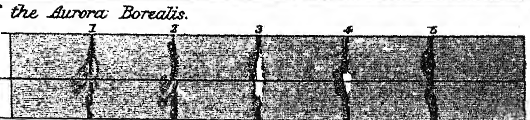


Fig. 5. Contortions of F line. 1 and 2. rapid down-rush hydrogen. 3 and 4. up-rush of bright, and down-rush cool hydrogen. 5. local down-rushes, hydrogen at rest.

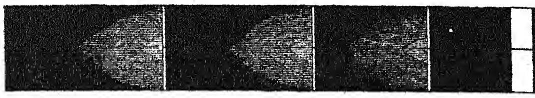


Fig. 4. Spectrum of Winnecke's Comet. 1868.

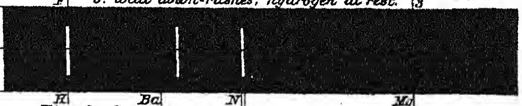


Fig. 6. Spectrum of the nebula 37 H IV. Draconis.

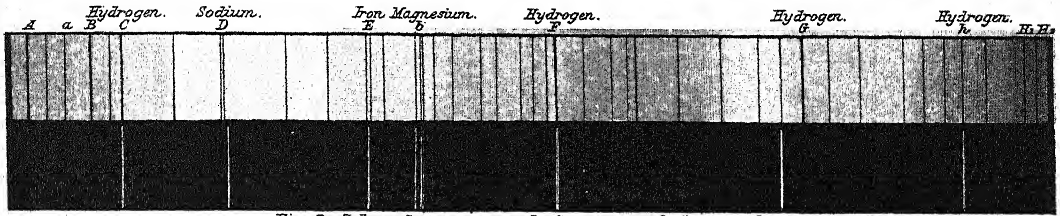


Fig. 7. Solar Spectrum, and Spectrum of Chromosphere.

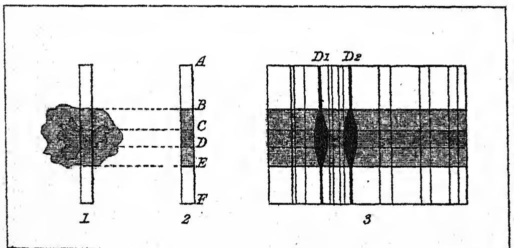


Fig. 8. Sun Spot and part of its spectrum near line D.

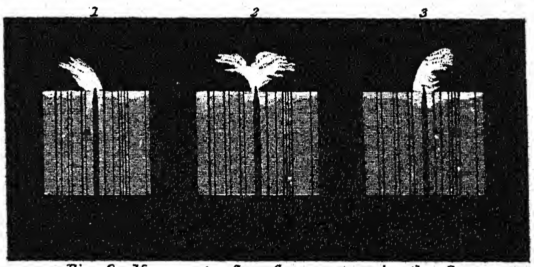


Fig. 9. Movement of a Gas-vortex in the Sun.

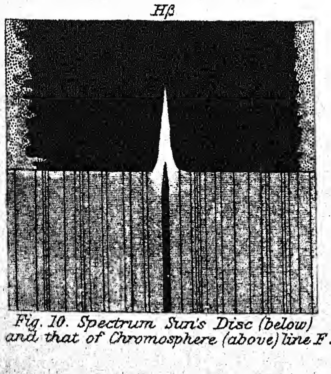


Fig. 10. Spectrum Sun's Disc (below) and that of Chromosphere (above) line F.

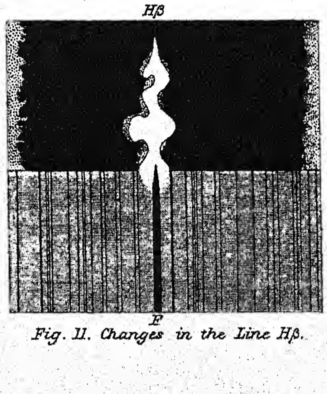


Fig. 11. Changes in the Line Hβ.

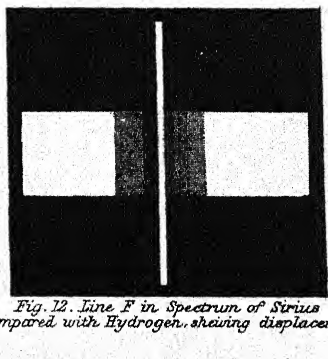


Fig. 12. Line F in Spectrum of Sirius compared with Hydrogen, shewing displacement.

ASTRONOMY.—CHAPTER XV.

SPECTRA OF SUN-SPOTS—NATURE OF SUN-SPOTS—SPECTRUM OF FACULÆ—SPECTRUM OF PROMINENCES—WIDENING OF HYDROGEN LINE—SPECTRUM OF CORONA—SPECTRUM OF CHROMOSPHERE—DETERMINATION OF MOTION BY SPECTRUM—DISPLACEMENT OF HYDROGEN LINE—SPECTRA OF THE PLANETS—SPECTRA OF COMETS—SPECTRA OF THE STARS—CLASSIFICATION OF STAR SPECTRA—MOTION OF SIRIUS—SPECTRA OF NEBULÆ—SPECTRA OF METEORS—SPECTRUM OF LIGHTNING—SPECTRUM OF AURORA BOREALIS.

ONE of the most remarkable results of spectrum analysis, is that which enables the measurements of velocities to be determined by the displacement of the position of the spectrum lines of a star or other source of light (as a prominence), and the movements of the luminous body to be ascertained, whether approaching or receding, with the velocity of its motion. Doppler first suggested, in 1842, the principles on which these investigations are conducted, when he sought to explain the periodic change of colour in variable stars by assuming their velocity to bear some relation to that of light, and therefore that the number of ether waves striking the eye in a second would be greater if the source of light were approaching the earth, and smaller if it were receding from it, than if it were at absolute rest. As violet light produces the greatest number of vibrations in a second, and red light the fewest, if the star is approaching, its light in the spectrum will be displaced in the direction of the violet; and if receding, in the direction of the red; and as the variations of pitch in sound depend on the rapidity of the air vibrations, as exemplified by the syren, so variations of colour are regulated by the number of vibrations in the ether wave; therefore, if the glowing hydrogen gas of a solar prominence be receding rapidly from us, fewer waves will strike the optic nerve in a second than if it were stationary; and if the difference in the number of waves be sufficiently great to be perceived by the eye, then each colour of the glowing gas must incline more towards the red, and the individual coloured rays will not occur in the same place of the spectrum in which they would have appeared had the source of light been stationary—they will all be displaced somewhat towards the red; and the converse will take place if the luminous body is rapidly approaching us, as they will all suffer displacement towards the violet. As the waves in red light are at least 480 billion, and in violet 800 billion in a second, and the wave of the greenish blue light of H β at F in the solar spectrum is only 485 millionth of a millimetre, the exceeding delicacy of the measurements can be understood.

The displacement of the F line (H β, fig. 1, Plate XI.) towards the red and violet is shown in fig. 9, which represents a cyclone or circular storm on the sun observed by Lockyer. The image of the bright line F in the chromosphere appeared in the spectroscope as in No. 1, and a slight movement of the slit of the spectroscope gave in succession the contortions shown in Nos. 2 and 3. The simultaneous displacement of the bright F line in No. 2 towards both red and violet indicated that at that place on the sun a portion of the hydrogen gas was moving towards the earth, while another portion was going in an opposite direction away from the earth towards the sun, so that the whole action of the gas in motion resembled that of a whirlwind. By means of the distances from the normal dark line F, which are taken from Angström's maps of the solar spectrum, and marked by dots, the individual displacements to which the H β line is subjected in consequence of motion may be determined, and from this the velocity of the movements of the gas estimated. Lockyer found that the furthest displacement of the F line corresponded to a shortening of the wave-length that indicated a velocity in the stream of gas of at least 147 miles in a second in the direction from the sun towards the earth.

The spectroscope can give comparatively little information regarding the constitution of the planets and their satellites and the moon, as all these bodies shine by the reflected light of the sun, and not by any light of their own. Their spectra are therefore, for the most part, the reflection of that of the sun, so that all that can be learned is whether this has been modified by any absorbing property of their several atmospheres. The moon gives no indication of any modification of this kind, and this evidence therefore, as far as it goes, negatives the theory of a lunar atmosphere. An observation of Huggins' is, however, very decisive; he watched the occultation of a star by the dark limb of the moon. If the star had suffered any appreciable refraction by a lunar atmosphere, the violet end of the spectrum would have been visible a little longer than the red, as it would have been more refracted. Nothing of the kind was noticed, the entire spectrum vanishing at once. Mercury, Venus, and Mars give the usual solar spectrum, but, in addition, there have been noticed bands agreeing in position with some of the telluric bands, particularly in the red, and in the case of Mars near D. The careful observations of Dr. Vogel and others have rendered it very probable that they are due to the atmosphere of the planet under inspection. Jupiter and Saturn, like the smaller planets, show traces of absorption by aqueous vapour, in addition to the reflected solar spectrum. But in addition there is a band in both spectra that cannot be assigned to either of these origins, and therefore it is concluded that the atmospheres of these planets contain some vapour or gas with which we are unacquainted. The two outer planets, Uranus and Neptune, especially the former, present very remarkable spectra. The faintness of their light does not permit the Fraunhofer lines to be distinguished, nor are the telluric bands observable.

In the spectrum of Uranus, Huggins observed six strong bands, which have also been seen by Vogel. One of the darkest is coincident with the blue green line of hydrogen (F), but none of the others have been clearly identified. Another strong band is coincident with the one remarked in the spectra of Jupiter and Saturn. There are no bands in the spectrum of Uranus similar to those produced by the absorption of the earth's atmosphere. The faint light of Neptune gives three bands in its spectrum, agreeing, within the limits of observation, with three of the darkest in that of Uranus. The red is entirely wanting, which is doubtless due to absorption. The spectrum of Neptune is in agreement with the beautiful sea-green tint of the planet. A peculiar interest attaches to this spectrum from the coincidence of the dark bands with the bright bands of certain comets, and with the dark bands of stars of the fourth type.

The application of spectrum analysis to comets has at present been limited, the comets that have visited our system since its application to astronomy having, with one or two exceptions, been very small and insignificant. The first comet the spectrum of which was observed by Donati, yielded only three bright lines, showing the presence of a glowing gas. Huggins and Secchi in 1866 found Tempel's comet gave, in addition to the three bright lines, a continuous spectrum. No dark lines were, however, perceived in the latter, the light being probably too faint to admit of their being seen. The continuous spectrum yielded by Coggia's comet of 1874, however, gave some dark lines, and from this it is reasonable to conclude that the continuous spectrum given by comets is simply due to reflected sunlight. Huggins and Secchi in examining the head of Winnecke's comet in 1868 saw three bright bands besides the continuous spectrum, and on comparing them with olefiant gas, found that they were exactly coincident with the three principal bands of the carbon compounds (fig. 4, Plate XI.) The observations of Coggia's comet gave the same result; in all cases the tail of the comet only gave the spectrum of reflected sunlight. It therefore may be concluded that the nuclei of comets not only emit their own light, which is that of a glowing gas, but also, together with the coma and the tail, reflect the light of the sun. There appears, therefore, nothing to contradict the theory that the mass of a comet may be composed of minute solid bodies separated one from another in the same way as the infinitesimal particles forming a cloud of dust or smoke, and that as the comet approaches the sun the most easily fusible constituents of these small bodies become wholly or partially vapourized, and in a condition of white heat overtake the remaining solid particles, and surround the nucleus in a *self-luminous* cloud of glowing vapour. It may, therefore, be concluded that comets, besides reflecting the sun's light to us, shine by light of their own, that light consisting probably of incandescent carbon or some of its compounds.

Spectrum analysis of the stars shows that three elements are found in nearly all that have been examined, viz. sodium, magnesium, and hydrogen. Iron is also frequently found. Sirius, Vega, and Pollux give evidence of these four elements. These results show that the stars resemble our sun in that they consist of an incandescent nucleus, surrounded by the absorbent vapours of various elements, many of which are well known. An unlooked-for event occurred on the 12th of May, 1866, which renders it more than probable that prominences also are as much a feature of the economy of the stars as of our sun. In the Northern Crown, a faint star of the ninth magnitude suddenly attained a brightness exceeding that of the second magnitude, and then rapidly faded away till, by the end of the month, it again became of the ninth magnitude. On the 16th May, when it was about the fourth magnitude, Huggins examined its spectrum, and found that in addition to a spectrum analogous to that of the sun, it presented four bright lines, two of which were due to hydrogen, and their great brightness indicated that the luminous gas was hotter than the photosphere. These facts lead to the remarkable inference that the star had suddenly become wrapped in intensely luminous hydrogen. Many of the variable stars show the hydrogen lines bright, and in η Argûs, even D^3 appears, which is the same yellow line seen in the prominences, a circumstance which increases the analogy between our sun and the fixed stars. Secchi, who examined the spectra of most of the stars visible in the latitude of Rome, divides them into four groups or types. The first class, the white stars, of which Sirius and Vega are the types, yield spectra crossed by four dark lines due to hydrogen, and much broader than those in the solar spectrum. Fainter lines may be seen with the most powerful instruments. The lines of sodium and magnesium may be easily identified in the brightest stars. The second class consists of the yellow stars, of which our sun is the example. In the spectra of these stars the dark lines are very fine and numerous, those of magnesium being often very distinctly marked. Arcturus, Capella, Pollux, and Aldebaran belong to this class. The third group give exceedingly beautiful spectra crossed by eight or more dark bands, very dark and sharp towards the violet end of the spectrum, and gradually growing fainter towards the red end. α Herculis furnishes the most remarkable spectrum of all: α Orionis and Antares are the principal stars of this type. The bands are resolvable into individual lines, and their sharp edges occupy the same position in all the stars of the type, two of them being marked by the lines D and b (fig. 7, Plate XI.) The fourth group consists of the red stars, which show three large bands of light alternate with dark spaces, having the most luminous side towards the violet. The characteristics of these two last groups seem to infer the existence of compound bodies or metalloids in their atmospheres.

An exceedingly interesting investigation is that to determine the velocity of movement in the line of sight of the brightest stars, from the displacement of certain lines. Fig. 12, Plate XI., shows the relative positions and appearances of the F line in Sirius, and the hydrogen line produced in a vacuum tube. The principal stars showing a motion of approach towards the earth are α Andromedæ, Pollux, α Ursæ Majoris, Arcturus, ε Boötis, Vega, α Cygni, and α Pegasi. Those receding from the earth are Aldebaran, Capella, Rigel, Betelgeux, Sirius, Castor, Procyon, Regulus, β, δ, ε, γ, and ζ Ursæ Majoris, Spica, and α Coronæ. The rate of motion varies from about 12 to 55 miles per second; that of Sirius has been variously estimated at from 26 to 40 miles per second.

These observations tend to confirm the conclusion that our solar system is moving rapidly in the direction α Herculis, for the majority of the stars observed in that portion of the heavens seem to be approaching the earth, and most of those [illegible] the opposite half receding from it. The nebulæ give no [illegible]e of the rainbow-tinted band given by the stars, but only [illegible] bright lines due to luminous gas (fig. 6. Plate XI.) [illegible] the lines, the faintest, is coincident with F, the bright- [illegible] one of the close pair of green lines of nitrogen; the [illegible] at present not been identified. All the gaseous [illegible]t give the same number of lines. In the brightest nebulæ a fourth line still more refrangible is seen, which coincides with the bright hydrogen line $H\gamma$. Probably the spectrum of all the gaseous nebulæ consists of four lines, but in the faintest of the nebulæ it is difficult to observe more than the brightest line. Two lines agree with those of hydrogen, and declare its presence in the nebulæ. The apparent coincidence of the brightest line with one of a pair of nitrogen lines does not, however, conclusively prove that nitrogen exists in the nebulæ. Some nebulæ give a faint continuous spectrum in addition to the bright lines. The results of these investigations are that those nebulæ giving a continuous spectrum may safely be assumed to be clusters of actual stars, while those giving only bright lines are simply masses of luminous gas, of which probably nitrogen and hydrogen form the chief constituents.

The rapid motion and transitory character of meteors render spectroscopic observation of these bodies extremely difficult. The spectra of the heads of the meteors are generally continuous, showing all the prismatic colours except violet. In some instances the yellow preponderated in the spectrum. In two instances the spectrum gave a homogeneous green tint. The light of the nuclei of the August and November meteors exhibited no difference, although in most of the August meteors only one yellow line of great brightness remained in the spectrum of the tail or track of light left when it began to dissipate, the unmistakable indication of the presence of luminous gas, while in the November meteors the spectrum of the train was characterized by continuity and breadth and a deficiency of colour. The light, mostly blue, green, or steel colour, appeared in most cases to be homogeneous. The yellow line presented by the train of the August meteors is altogether wanting in that of the November meteors. From these investigations it may be affirmed that meteors consist of incandescent solid bodies, and that the heat they are subject to in passing through our atmosphere is often sufficient to volatilize such elements as sodium or magnesium, and that a difference is distinguishable in the chemical composition of the August and November meteoric showers.

The spectrum of lightning gives numberless bright lines, among which the blue nitrogen line is the most prominent, and the red line of hydrogen, $H\alpha$; at the same time there is a continuous spectrum exhibiting the principal colours, and formed of a great number of bands, fainter and broader than the lines and disposed regularly at equal intervals from one another. The spectra of lines are usually given by the forked flashes, sheet lightning yielding the spectra of bands. The two kinds of spectra correspond with the difference of colour, the light of forked lightning being usually white, while that of sheet lightning is mostly of a reddish tint, although sometimes bluish and violet. The light of the electric spark always gives a spectrum of lines, while that of the brush discharge or glow exhibits a spectrum of bands.

In the spectrum of the aurora borealis Angström found always one bright line situated to the left of the well-known calcium group of the solar spectrum, and sometimes traces of three very faint bands near the F line. The light of the aurora borealis is therefore almost homogeneous. Angström has also observed the same line in the zodiacal light; this bright line is not coincident with any known line of a terrestrial element. The aurora spectrum has also been found to indicate five bright lines (fig. 3, Plate XI.); of these lines the third is the brightest. None of the lines in the spectrum of the aurora borealis are found to be coincident with any known spectra of gases of our atmosphere, and it is therefore assumed that if the light developed by the aurora be chiefly of an electric character, it must belong to a temperature lower than that at which it is possible to observe the spectra of gases rendered luminous by the electric discharge in a Geissler's tube.

Photography has recently been successfully applied to the production of maps of the spectrum, and although the spectrum does not end where it ceases to be visible, either at the red or violet ends, Abney and Vogel have discovered methods of rendering bromide of silver sensitive to rays of all colours, by which both portions, the ultra red and the ultra violet, ordinarily invisible, can be mapped out, and show absorption

lines precisely similar in character to those seen in the visible portion of the spectrum.

PENMANSHIP.—CHAPTER XIV.

ENGROSSING—FIGURING—PUNCTUATION AND THE USE OF CAPITALS.

THE culture of pencraft was carried to a far higher pitch with our forefathers than with us. Before the printer superseded the scriptor, antique artists produced those wondrously illuminated manuscripts which are the joy of the palæographer, and the fine traditions of caligraphic skill were well kept up by the professional scrivener, who delighted to produce in "deed, bill, warrant, quittance, or obligation," work "which in a set hand fairly is engrossed." Even yet from the painstaking assiduity and care employed in giving neatness and elegance to the handwriting, so that the clerkly pen might by

"Strokes inimitably fine
Crown with perfection every flowing line"

of documents meant for the charter-chest and the muniment room, a great part of the expressiveness of our meaning is derived when we speak of a man's engrossment in any business or pleasure. Engross—as a term in penmanship—the erudite Randle Cotgrave informs us is derived from the old French *engrossoyer*, to write fair or in great (*i.e.* French *gros*, large) and fair letters. The word is used in contradistinction to the minute or small characters in which the original draught of a document was written. The minutes were retained by the notary and were called the notarial copy, while the engrossed copy was delivered to the persons interested. Technically, it signifies the making of a fair copy, "writ large," of any document in a clear, distinct, legible, legal hand, and therefore what may be called an old-fashioned hand; but in the ordinary language of the counting-house, to engross is used merely to mean to copy out clearly and distinctly. It is, however, both for the sake of being able to read legal documents and of copying them, of great advantage to know and to be able to write "engrossing hand," and we propose to supply a few instructions on this important part of business penmanship.

On turning to page 66 the student will find a table of the German alphabet, and in the second column of it the German character of the letters is given. On comparing these letters with those supplied in the third division of penmanship, Plate III., it will at once be seen that there is a considerable family resemblance between the two. It seems not at all improbable that the "black letter" of German and "Old English" books is in reality an angular and corrupt form of the Roman letters employed for ease' sake by the monks, who in the middle ages were much engaged in copying MS. The form which letters assume must primarily depend on the material written upon and the instrument used in writing. Graven lines incline to be straight and of uniform thickness, drawn ones tend to become curved, and not only to shade off towards the terminal points, but to be, in general, thick when the stroke is downward, and thin when it is upward. Curved lines again afford facilities for taking cursive forms, and love of variety and man's delight in ingenuity may well be considered as accounting for changes of form in the caligraphy of different nations and periods. Of course, printing and a more general intercourse by correspondence has had a steadying effect of late years, and love of variety is now exercised almost exclusively in ornamental writing, and exercises little effect on ordinary penmanship.

German text—though now often regarded as a merely ornamental form of writing—is, in its capitals, a good deal like the Gothic, from which German sprang, and in its minuscular forms is rather a stiff upright reproduction of our common round-hand character. On account of this peculiar perpendicularity, the pen in engrossing is held in a different manner than it is when producing the usual English script. In engrossing, it is held between the fleshy points of the middle and the forefinger, when the nails are turned towards the paper, with the side of the thumb-point on the top of the pen, the pen itself resting loosely, hollow downwards, on the point of the middle finger and on the knuckles of the forefinger, the direction of the instrument being from left to right. This position is adopted that the pen may easily revolve by the pressure of the thumb a little to the left when a perpendicular line is to be formed, and to the right when a horizontal one is required. The easiest order in which to practise the small letters is to adopt *i* as the normal element, and to proceed with *u*, *n*, *m*, *r*, *x*, *v*, and *w*. Having managed *v*, the *o* forms may be taken thus—*o*, *a*, *c*, *g*, *q*, *p*, *d*, and *e*. Next take *l*, *h*, and *b*. If *t* and *k* are taken as one pair, and *s* and *f* as another, and care be spent upon them, the distinction between them will be impressed on the mind. It will be easy to do *x*; *z* has a form already familiar, and *y* will be most simply managed by writing an *i*, and drawing a half-oval convex to the right, at about an eighth from the top. After acquiring readiness in their production in this order, form the letters into verbal exercises, including as many as possible (1) of those similar in the first instance, and then (2) taking the most diverse—*e.g.* Namur, rover, wax, ocean, gip, dip, quip, health, belch, tick, take, safe, false, axe, zebra, kex, zest, yest, acidulous, assiduous, persistent, excellence, cold, bath, &c.

The capital letters in engrossing hand are often, from their broken appearance, called "fracted." The curve in them is the prevailing line. It occurs in its freest, fullest form as the first element in N, M, R, X, and W, and in a smaller size as the first element in V and Y. In B it takes a horizontal rather than an upright position. The last element in N recurs in M. The letters O and Q are very similar—the latter having a slight addition in its second element. The shape of S is rather peculiar, and recurs in a smaller form in F, which, however, is cut by a straight line. In a still smaller form, it occurs in C with a Hogarthian line slightly slanting below it, in E with a dot to the right, and a larger line of beauty. The I form reappears in the latter part of V and W, in a smaller form in T and H, both having a Hogarthian line below them, and the latter having a small semi-oval attached to the lower part on the right. It occurs also in the last part of P, and in a diminutive size in the first part of U. In L we have an ordinary small *s* with a line of beauty beneath it, and K resembles a long English S with a second element attached similar to but smaller than that which appears in R. The letters A, B, D, G, and Y require a great deal of patient practice, but may be made very beautiful. As in almost all alphabets, Z is a curious form, which, however, seldom occurs. As a practical guide in studying these capitals, we commend beginning with the larger ovalesque curves, which are almost all made with a backward sweep from left to right. Next take all the forms of the Hogarthian sweep, large and small, compounding them where necessary. In few of the letters has it managed to become a thing of beauty, though its combinations are not unattractive. It requires a considerable effort at first to keep these capitals fairly upright. A quill is usually employed in engrossing, though special steel pens are also manufactured for this kind of writing. Other analyses of these letters have been made, but none appears to be simpler. One of the best engrossing clerks in London says, "To engross well one must have a clear-seeing eye, special muscular dexterity in the motion of the hand, and instantaneous readiness of touch."

The formation of good figures is of great practical importance, and it may be a useful appendix to penmanship to give some directions which may preclude the possibility of figures being misread by securing that they may be plain and perfect.

Figures ought to be made one-half higher than the unit height of the letter *i* in writing; 1, 2, 3, 4, 5, 8, and 0 should all be of the same size, and should occupy the width of the normal M. Write 2 exactly like Q. The top part of 3 should be one-third of the height, and the line of the ovalesque curve of the lower part should rise to one-half; it resembles a capital E reversed. The figure 4 is best made by an angular (not a looped) joining of the upright and horizontal line. The cross line cutting the horizontal line should commence one-half from the top and descend one-third. A 5 should be formed by a slant-line one-third of height, to which attach an ovalesque curve as in the lower part of 3, and to the right of the top of the slant line affix a horizontal Hogarthian line of

an m's width. For 6, beginning at two heights of unit *i*, bring down a slightly curving slant line to base, at which form, rising to one-half the height of the line, a complete oval, like the last element in capital C. In forming 7 begin with a horizontal line of beauty at the height one and a half *i*, to this join angularly a straight slant line descending one-third of height below the main body of the other figures or writing. An 8 is commenced at the usual height with a slightly curving slant line, which form into an ovalesque base curving from left to right till at two-thirds height it crosses the down slant line, and from that crossing point form a half oval on the left of the line crossed to meet the top where the figure was begun. In forming 9 make at the usual height an oval like O, two-thirds of the figure size, and to this attach a down slant line extending from joining at top one-third below the base of writing. The cipher is formed exactly like the letter O.

Punctuation (*i.e.* the division of written matter into sentences and parts of sentences) aids greatly in making what is written clear in meaning and pleasant in reading. It was very little used by the ancients, though the Alexandrian grammarians pointed out its use for oratorical purposes, and Alcuin, in the days of Charlemagne, introduced a simple form of subdividing sentences by points. The Venetian printer Aldus Manutius invented our present system of punctuation in the fifteenth century. The grammatical marks used in punctuation are as follows:—(1) Comma [,] (Gr. *komma*, a segment), for separating the smaller subdivisions of sentences, especially when words intervene between a nominative and its verb, when easily understood words are omitted, and when modifying words are employed; (2) semicolon [;], used to mark off the conjunct members of a sentence; (3) colon [:] (Gr. *kolon*, a limit), employed when the sense of a sentence is complete, but it is found desirable to add some further remark in illustration or enforcement; (4) period [.] (Gr. *periodos*, a circuit), indicating the completion of a sentence. The following are rhetorical points:—(1) Exclamation [!], suggesting emotion; (2) interrogation [?], inquiry; (3) parentheses [( )], a portion grammatically independent inserted in a regularly constructed sentence; (4) dash [—], single denotes an abrupt turn of thought; double [— —], a useful or explanatory remark interjected in a sentence; (5) quotation [" "], inverted commas, indicates that the words so marked have been used by some other person than the writer.

In English writing, capital letters begin (1) every sentence, (2) every line of poetry, (3) names used to designate the Supreme Being, (4) proper names and adjectives derived from proper nouns, as well as names of days, months, festivals, titles of books or of honour, &c., and objects personified, (5) the pronoun I, (6) the interjection O, (7) the first word of a direct quotation, and not unfrequently any leading or emphatic word. In preparing manuscript for the printer, when words omitted are required to be introduced, a sign, *caret* [^], is placed in the line to show where the matter is to be taken in; a single line is drawn under any word or words which are to be put in Italics; two lines indicate small, and three lines large capitals.

NATURAL PHILOSOPHY.—CHAPTER XXX.

ELECTRIC LIGHTING—ARC LAMPS—MONOPHOTAL AND POLYPHOTAL ARC LAMPS—ELECTRIC CANDLES—INCANDESCENT LIGHT WITH COMBUSTION—INCANDESCENT LAMPS—SECONDARY BATTERIES—STORAGE BATTERIES—ELECTRIC LIGHT APPLICATIONS—INDUCTION CURRENTS—MAGNETO-ELECTRICITY—MAGNETO-INDUCTION CURRENTS—INDUCTION COIL—CURRENTS INDUCED IN MASSES OF METALS—MAGNETO-MACHINES — DYNAMO MACHINES — DYNAMO-ELECTRIC MACHINES—DYNAMO ELECTRICITY.

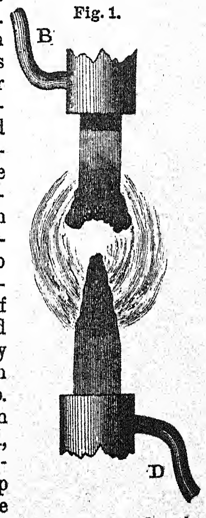
VOLTAIC ARC—ELECTRIC LIGHT.

WHEN the circuit of a voltaic battery is suddenly closed a spark is obtained at the point of contact, which is often of considerable brilliancy, and a similar spark is also perceived on breaking contact. The tension of the voltaic battery, however, is never sufficient to cause the spark to pass between the electrodes unless they are previously brought into contact. The voltaic arc between carbon terminals was first produced by Sir Humphrey Davy in 1813 with a battery of 2000 elements; but until the experiments of Deteuil in 1842 the possibility of its practical use as a source of illumination was not suggested, from the imperfections connected with the apparatus both for generating the current and regulating the light. In 1857 Van Maldern demonstrated that electric light could be advantageously produced in certain special cases, and the illumination of the lighthouses of La Hève by electricity in 1863 brought the electric light for the first time into notice. The invention of the dynamo-electric machine gave a further impetus to the electric light; and Jablochkoff's invention of the "electric candle" in 1876 inaugurated a new system of electric lighting.

All electric lighting is dependent upon two distinct factors—the electric generator and the electric lamp. The fundamental principle of the production of light, whether with oil, petroleum, gas, or electricity, is to bring a solid (or gaseous) body to a high temperature, the quantity of light produced being the greater the higher the temperature of the body. The high temperature of the luminous part of the electric arc is produced by the resistance which the partially volatilized carbon offers to the passage of the current, its energy being converted into heat within a very restricted space. When the electric current heats a gaseous conductor the light produced forms the voltaic arc. Unless the gaseous conductor contains solid particles detached from the electrodes it is never very luminous. It is the solid particles, when raised to a very high temperature, that emit the characteristic dazzling light of the arc. For the production of the electric light conductors of gas carbon or very dense charcoal are used. If a solid conductor of feeble conductivity is heated by the current and rendered luminous, the light is said to be produced by *incandescence*. There are therefore two distinct methods of producing the electric light, according as the conductor is solid or gaseous. Matteucci, who in 1850 investigated the conductivity of the arc passing between points of various substances, found that it depended chiefly upon the fusibility and volatility of the substances forming the points. He also observed the difference of temperature of the two poles, which increases with the non-conductivity of the materials forming the poles, and also with the facility with which these materials are dissociated, the + pole being nearly twice as hot as the − pole. This unequal heating causes a difference in the disintegration of the substance and modifies the electrical resistance, which may vary from 0·5 ohm to upwards of 100 ohms.

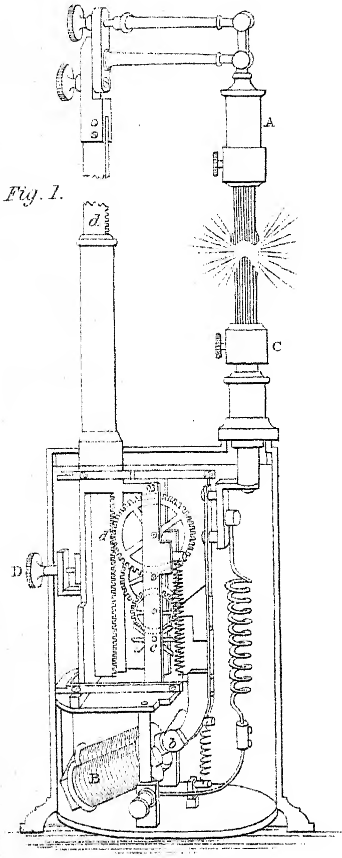
The length of the arc varies with the tension of the current; it may extend to 4 or 5 centimetres with appropriate currents. When the arc is short it generally assumes a cylindrical contour. It is also found that the arc exerts an opposing electro-motive force of its own, and tends to set up a counter current. When the voltaic arc is prolonged it becomes less condensed and more slender, and has an envelope surrounding it resembling the appearance of a flame. The central part is composed of incandescent particles, which detach themselves from the heated extremities of the points and appear to attract one another, forming a continuous stream. The exterior parts of the arc consist of more finely divided matter. In air the voltaic arc rapidly and unevenly consumes the carbons in the proportion of about one to two. The result of this unequal combustion is that the luminous point is displaced, and that the electrodes become deformed; the − pole presents a sharp point, as at D, fig. 1, while the + pole assumes a hollow crater-like shape, and surrounds the luminous point with a more or less prominent fringe, as at B. These phenomena are produced with continuous cur-

Fig. 1.



ELECTRIC LIGHTING — ARC LAMPS

Fig. 1.



Serrin's Regulator.

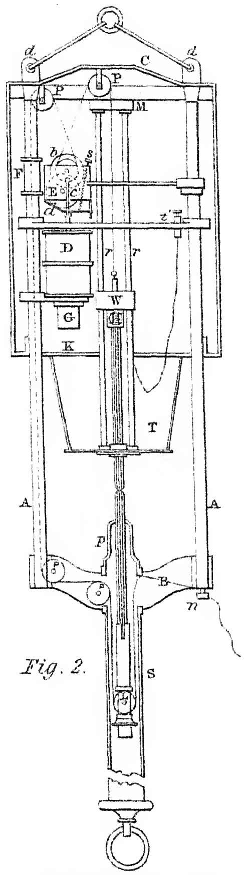
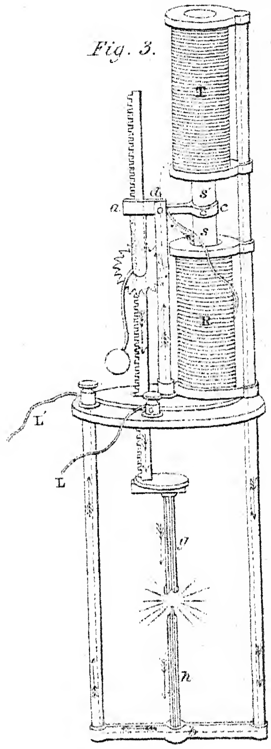


Fig. 2.

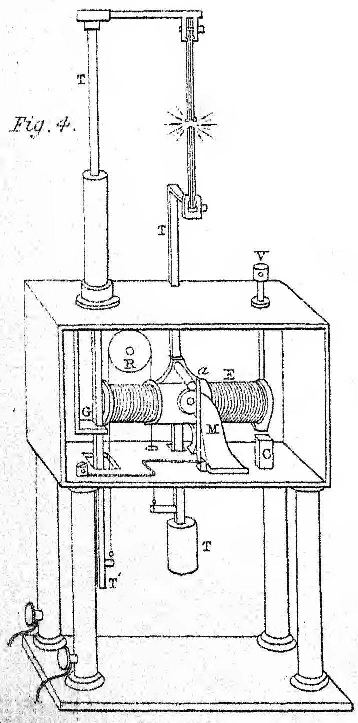
Crompton Lamp.

Fig. 3.



Siemens' Differential Lamp.

Fig. 4.



Gülcher Lamp.

Fig. 5.

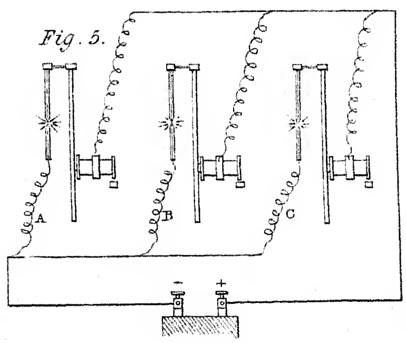
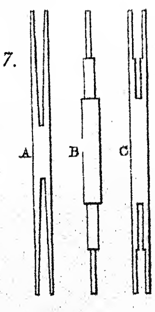


Fig. 7.



Pilsen Cores.

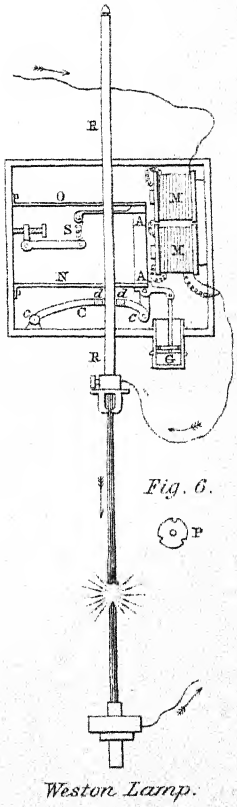


Fig. 6.

Weston Lamp.

rents. With alternating currents the waste of the carbons is even and regular, and both extremities assume a pointed shape. In electric illumination the hollowed electrode acts as a reflector, and when the lamp is at sufficient elevation the floor receives a larger amount of light than the ceiling, which is always an advantage.

For lighthouse illumination the concave surface of the + electrode, with a convenient arrangement of the − carbon, supplies a much greater intensity of light in a given direction. Continuous currents are therefore preferred to alternating currents for the lighting of lighthouses. A light thus produced is termed a condensed light, and is obtained by placing the lower − carbon in such a position that its axis is in the prolongation of that side of the upper carbon which faces the horizon that is to be illuminated. By such an arrangement, if the light produced by the carbons is 100, the following intensities are obtained:—

In front,	287
On each side,	116
Behind,	38

Condensed light or ordinary light may therefore be advantageously employed, according to the intended applications.

The employment of pure carbons for the production of the electric light is a matter of great importance, otherwise the light is unsteady, from the intense heat producing an undue amount of ash and flaking off of the points. Carré manufactures on an extensive scale carbon rods containing metallic salts which, according to their nature, give to the flame a greater steadiness or a more agreeable tint. A mixture of very pure fine charcoal powder, coke, and lamp-black is thickened with syrup of sugar; it is well triturated and passed through a draw-plate under a pressure of about 100 atmospheres; the sticks are then baked and dipped while red hot into the syrup, baked again, dipped again, and so on a certain number of times. The carbon thus prepared is a good conductor, burns slowly without cracking, and without giving too much flake. Gauduin employs charcoal, the residue obtained by the destructive distillation of tar, resin, bitumen, &c., the moulding being effected at a very high pressure by a hydraulic press. Napoli, of Paris, produces carbons of high quality, and on a large scale. He employs gas-tar and the residue of coal slowly distilled at a dull-red heat. The carbons are of great hardness, and have a fine fracture, like that of crucible steel. In this condition they are used for electric lighting, burn with perfect steadiness, and give a pure white light.

The appliances designed for the production of the voltaic arc, and which regulate more or less accurately the distance of the carbon points and the steadiness of the arc, are so numerous that only the more important can be noticed here. They may be divided into two groups, according to the relative position of the carbons—arc lamps and electric candles. In the arc lamp the light is produced between two carbon points, placed end to end by a self-acting apparatus, which likewise regulates the distance between the points; in the electric candles the carbons are placed parallel to each other—they are also free from the complex mechanism found in the arc lamp, which constitutes in practice a great advantage. All arc lamps utilize the changes produced in the current to act upon a form of mechanism which regulates the distance between the two carbon points. In some only one light is supplied by a given electric source; in others two, four, ten, twenty, up to forty are supplied by the same current. Arc lamps are therefore divided into single light, or *monophotal*, and *polyphotal* or division lamps. All single-light arc lamps have the common characteristic feature that the electro-magnetic apparatus which regulates the distance of the carbons is placed in the same circuit as the arc itself, and is therefore traversed by the whole of the current, the variations in the intensity of the current causing the approach or the separation of the carbons.

The first arc lamps were all constructed upon this principle; the variation of the current acted sometimes upon a solenoid and sometimes on an electro-magnet controlling a clockwork movement. In Foucault's regulator the carbon-holders are propelled by a train of clockwork wheels kept in motion by a spring. An electro-magnet, through which the current flows, attracts an armature and governs the clockwork. When the current is too powerful the armature is drawn down and the clockwork withdraws the carbons further apart; when it is weakened by the resistance of the arc the armature is drawn up by the action of a spring, and allows a second train of wheels to come into play by which the carbons are moved nearer together.

Serrin's regulator, somewhat upon this principle, has found a great number of practical applications, as it fulfils in a comparatively simple manner all the requirements of an apparatus of this kind. When no current is passing the carbons are in contact; when the current is established they separate to the required distance, and then approach one another slowly without coming again into contact. Should the arc be broken by a strong wind or the fracture of a carbon, the arrangement brings the carbons again into contact, and then removes them to the required distance, so that the voltaic arc is at once reproduced with all its pristine brilliancy. To carry out these arrangements the + carbon-holder A (fig. 1, Plate XXVII.) consists of a rackwork *d*, acting on a series of multiplying wheels for the increase of speed, the last of which corresponds with a wheel carrying a certain number of long teeth in the form of a star. When no current passes and the carbons are separated, a motion of the wheels takes place until the carbons touch. At the same moment the electro-magnet B comes into action, attracts the armature *b*, and causes the descent of a movable oblong check, to which it is fixed, to arrest the motion of the star wheel, and stop the descent of the upper + carbon A, and at the same time lowers the − carbon C, which is fixed to this movable piece.

When the arc is lengthened the intensity of the current is weakened; the movable piece is then raised by the action of two supporting springs, and sets free the large-toothed wheel *c*. The upper carbon A can now descend a certain distance, until the arc is sufficiently shortened and the intensity brought back to its normal strength, when a fresh stoppage takes place, and a new state of equilibrium is set up. On the contrary, if the carbons are too close to one another, the intensity of the current increases, the movable piece is more strongly attracted by the electro-magnet, and continues to descend, producing a lengthening of the voltaic arc. The spiral springs are adjusted by the screw D. As the + carbon descends and the − carbon ascends at the same time, and at a relative rate which is nearly as two to one, the luminous arc remains at a constant elevation.

In the latest form of the Crompton arc lamp (fig. 2, Plate XXVII.), the framework consists of two hollow rods A A, united at the top and bottom by iron cross-pieces B and C, which are each furnished with two small grooved pulleys P P, the upper one with lugs *d′ d′*, for slinging the lamp. To one side of the rod A is fixed the solenoid D, which is formed in two parts, the upper part being wound with a high resistance coil to form a shunt between the terminals of the lamp, while the lower division is placed in the main circuit. An iron core *c* moves inside the solenoid, to the upper end of which is attached a small clockwork movement E. The tube G below the solenoid serves to steady the up-and-down motion of the core.

The + carbon-holder H is furnished with a plate on which a weight W is placed for regulating the lamp; it is attached to, but insulated from, one end of a flexible metallic cord, which passes over the pulley P, round the wheel *b* in the clockwork, over a second pulley P, and down the tube A, and under the wheel L in the − carbon-holder, the other end of the cord being secured by the screw *n*. The + carbon-holder H is guided by two small rods *r r*, held at the top by the iron piece *m*, and insulated from it by porcelain tubes. The lower ends of these rods are secured to a porcelain insulator fixed to the bottom of the tin case T, which serves to exclude all fumes from entering the working parts of the lamp. The + carbon passes through the bottom of T, from which it is insulated by porcelain. The − carbon rises from its holder through the nozzle *p*; F is an adjustable stop clamped on the rod A, and serves to release the brake *d* from the brake-wheel E, when the iron core raises the clockwork high enough. The spring *s* is to give sufficient pressure on the wheel E, to

prevent it revolving when away from the stop F. The current enters at the terminal and passes round the solenoid D to the terminal t', which is insulated from the frame, and by means of a flexible metallic cord it reaches the + carbon-holder; it then traverses the − carbon, the holder of which is in connection with the frame of the lamp, and so passes to the next lamp. When the current passes round the solenoid its core is drawn down, and the carbons are separated. As the arc lengthens, the shunt coil draws the iron core up until the brake d is brought against F and the wheel c is released; the weight W, and with it the + carbon, then falls, at the same time raising the − carbon exactly half the distance. As soon as the lamp feeds, the current in the shunt coil decreases, and the main current pulls the brake d clear of the stop F, the arc again lengthens, and the same action is repeated. The adjustment of the lamp is by the position of the stop F and the weight W. The intensity of the light is between 2000 and 2500 candles for horizontal, and between 2500 and 4000 candles for downward rays.

When several monophotal arc lamps are connected in series in the same circuit they speedily become deranged, as in all these lamps the movement of the carbons is dependent on the action of an electro-magnet, which obeys the variations of intensity of the current which are produced by the lengthening or shortening of the voltaic arc. If two lamps are placed in the same circuit the lengthening of the arc of one is sufficient to set the two electro-magnets in action, and therefore at the same time to shorten both the voltaic arcs. In this case the second lamp immediately ceases to act, when all that was necessary was the regulation of the distance between the carbons of the first lamp. Again, one arc might be very long and the other very short without interfering with the equilibrium, since the intensity of the current will be the same as if the two arcs had the mean length necessary for their efficient working. When arc lamps are to be in series on the same circuit, it is therefore necessary, to maintain efficient performance, that the regulation of the carbons of each lamp should be independent of all the other lamps that are placed in the circuit. The polyphotal lamps fulfil this condition, and are all founded on the law of shunted currents, that the sum of the strengths in the divided parts of a circuit is equal to the strength of the principal current; and the strengths of the currents in the divided parts of a circuit are inversely as their resistances.

The differential lamp of Siemens, constructed by Hefner Alteneck, enables as many as ten lamps to be placed in series on the circuit of a Siemens alternating current machine, the action of each lamp being independent of all the rest. The principle of the regulation is the differential action which shunted currents exert in proportion to their relative intensities upon two circuits.

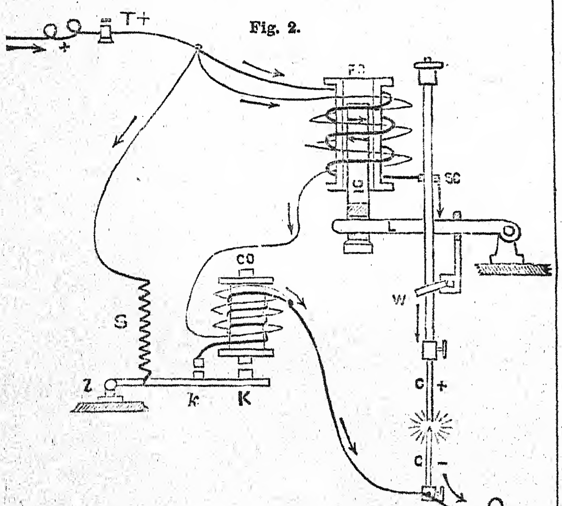
The action of the apparatus is simple. The main current enters the apparatus at L (fig. 3, Plate XXVII.) and divides into two parts; one part enters the coil T, formed of very fine wire and of great resistance, and leaves again by L′ to enter the next lamp in series on the circuit; the second part of the current traverses the coil R, wound with a short and thick wire, and leaves to traverse the voltaic arc formed between the carbons $g\,h$, whence it also passes by L′ over into the next lamp. The current is thus divided into two very unequal fractions: the weakest traverses the coil T, which has a fixed and very large resistance; the larger portion of the current traverses the voltaic arc, which offers a variable resistance as the carbons are consumed. The soft iron cores, $s\,s'$, working in the interior of each coil, are connected with the carbon g by a lever, $c\,d\,a$. As each coil attracts its corresponding core with a force proportionate to the intensity of current and to the number of turns of wire for a suitable resistance of the voltaic arc, the relative resistances of the two circuits will tend to equalize the actions of the coils on the rods $s\,s'$, and the lever $c\,d\,a$ will assume a certain position of equilibrium. If the resistance of the arc increases, this equilibrium is destroyed, the action of the coil T will predominate, and the lever $c\,d\,a$ will move on the centre d and cause an approach of the carbons. If the resistance diminishes, the coil R acts most forcibly on the iron rod s, and the carbons are separated; consequently the regulator does not act by the variation of the intensity of the current in the circuit, as in the Serrin lamp, but by the variations of the resistance of the voltaic arc. As the lower carbon is fixed, the luminous point descends in proportion to the waste of the carbons, but the mechanism being placed above the luminous point no shadow is thrown. The mechanism is inclosed in a copper cylinder, which preserves it and serves for the suspension of the lamp. Any one of the lamps may be extinguished and immediately relighted without interference with any other. There is also an arrangement for preventing the extinction of all the lamps of one circuit when the carbons of a lamp are burned out or have been neglected to be replaced. In the Gülcher arc lamp, which gives great steadiness of light and is simple in construction, the regulation of the carbon is effected by a single electro-magnet; the lamp is therefore cheap to manufacture and repair, and not liable to derangement. The two carbon-holders are connected by means of a cord which passes over a pulley, R (fig. 4 of Plate); the upper one, the rod of which (T′ T′) is of iron, being heavier tends to descend, and at the same time draws the other carbon-holder up. The rod of the upper carbon moves in close proximity to the pole of a cylindrical electro-magnet, E, which is mounted so as to have freedom of motion in a vertical direction on the axis a; the other pole of the electro-magnet is kept in contact with a regulating screw, V, by a spring, the tension of which can be adjusted. At starting the carbons are in contact; on the current passing through the carbons and the electro-magnet one of its poles adheres to the iron rod T′ T′ of the upper carbon, and keeps it in its place, while the other pole is attracted by the small iron block c placed beneath. The electro-magnet therefore moves on its centre a, and raises the upper carbon, producing the arc. The electro-magnet now begins to oscillate, and finally resumes its position against the screw V, where it remains so long as the current preserves its normal intensity. As the arc increases, the intensity gradually diminishes by the wasting of the carbons, and the electro-magnet releases the rod T′ T′ of the upper carbon, and the points approach each other. By this arrangement, when several Gülcher lamps are placed in circuit, the first lamp acts as the regulator of the second, the first and second as the regulator of the third, and so on. This regulating action depends on the motion of the electro-magnet and upon the quantity of current flowing into the circuit. When the lamp A (fig. 5, same Plate) is first lighted, by connecting the axle of the electro-magnet to the main conductor in connection with the + pole of the generator, the light establishes itself, as already explained; then if the connections with lamp B be completed the current is divided, and B is lighted. At starting the current flowing through B will be stronger than that flowing through A, because the carbons of B are in contact, and therefore offer less resistance; as a consequence the electro-magnet of B is set in motion, the carbons are separated, and the resistance is increased. At the same moment the current passing through A will be strengthened, bringing the carbons nearer together, and the equilibrium of the current is established between A and B. When C is lighted the same processes take place; the lamp A regulates B and C, B regulates A and C, and C regulates A and B, and so on for other lamps. The Gülcher lamp requires 1·66 horse-power for each lamp, giving an illumination of 135 carcels (2160 candles).

The action of the Weston arc lamp, which is simple, regulates itself with great accuracy according to the strength of the current, producing a steady white light, and gives very satisfactory results, is shown in fig. 6 of the Plate. The box at the top of the lamp contains the rod, R R, carrying the upper carbon. When no current passes this descends by its own weight, and the two carbons are in contact. When the lamp is started the electro-magnet M M attracts the armature A A, which, being suspended by the two spring-arms N O, can only move up or down. The rise or fall of the armature raises or depresses the curved arm O, to which it is attached, arresting or releasing the rod R by the grip of the collar $d\,d$. The tension of the spring S regulates the tension of the springs O N supporting the armature. The movement of the armature therefore depends on the difference between the tension of this spring and the attractive force of the electro-

magnet M M, which is wound alternately with coarse and fine wire in reverse directions, so that its action depends on the differential action of the currents which traverse these wires. The coarse wire is in connection with the main current; the fine wire is connected to the terminals of the lamp, and acts as a shunt of the main current. When the current enters the thick wire of the electro-magnet it passes down through the carbons, and ascends to the right of the lamp-frame, passing on to the next lamp. The electro-magnet M M being excited, lifts the armature A A, which carries with it the lever C and the rod R R, and the arc is established. The intensity of the current circulating through the shunt increases in proportion to the distance between the carbons and the resistance of the arc; as this resistance increases, the current traversing the shunt is strengthened and the attraction of the magnet lessened, the armature A is lowered, and the carbons approach nearer to each other, the shunt current consequently becoming less intense. Should the arc become extinguished the armature is entirely released, the carbons come into contact again, and the current is re-established. To moderate the fall of the armature, it is connected with the piston-rod G, which moves in a reservoir filled with glycerin. The disc of the piston is formed of two discs, P, each of which has three triangular notches on its circumference; one disc is fixed to the rod, the other is capable of being turned round, so that, according as the notches coincide or cover one another, the movement of the piston is regulated with great accuracy.

The Brush arc lamp is of great simplicity, the feed being actuated by gravity alone, while it is controlled solely by the influence of a magnetic field on a bar of iron; the intensity of the field varies with the strength of the current passing through the lamp circuit. The Brush system is capable of establishing a great number of powerful arc lights—as many as forty—in a single circuit. This is a great gain where several lights have to be employed, because if there are as many long conductors as there are lamps, then the entire loss of current due to the resistance of the cables must be borne by each lamp, whereas if the number of lights can be included in a single circuit the loss of current from the resistance of the conducting cable is divided among all the lamps in the series. The Brush arc lamp (which is shown in diagram form in fig. 2 below) is made with either a single carbon burning eight hours, or with a double carbon burning sixteen

Fig. 2.



Brush Lamp.

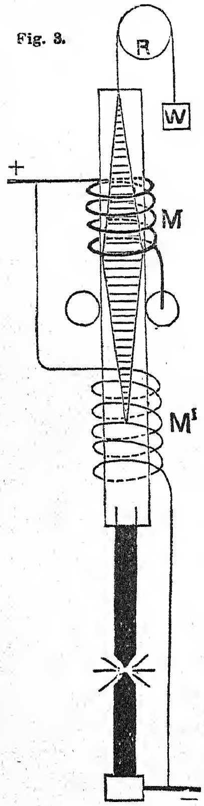
hours. In each case the lower carbons are fixed so that the arc gradually descends. The upper carbon, C+, descends by its own weight, completing the circuit; the effect of this is to cause a soft iron plunger, I C, to be drawn more or less within a hollow sucking coil, F C, and through the intervention of a lever, L, and an annular clutch, W, surrounding the rod of the upper carbon, it is lifted away from the lower and the arc established. As the arc lengthens the strength of the current diminishes, and the supporting power of the sucking coil is reduced, allowing the plunger to descend and the arc to be reduced until the proper strength of the current is restored, when the rising of the plunger once more locks the carbon in position. To insure the individual independence of each lamp and a uniform light, each coil of the controlling magnet is wound with two distinct coils of wire in a reverse direction, the first consisting of a number of turns of thick wire, through which the primary current is transmitted to the arc, and the second of a much larger number of convolutions of fine wire, which forms a shunt circuit of high resistance between the terminals of the lamp; this being always closed, is independent of the arc. As the current in the shunt is in the opposite direction, the influence of the fine-wire circuit will be to neutralize and weaken the attractive influence of the thicker wire helix, but the number of convolutions of the two coils, as well as their respective resistances, are so proportioned to one another that the attraction of the primary helix, when the arc is of its normal length, overcomes the influence of the secondary circuit. Owing to the greater resistance of the latter, not more than 1 per cent. of the main current is transmitted by the shunt, but owing to its large number of convolutions its magnetic influence is considerable. The electric current has therefore two paths from one terminal of the lamp to the other—the one through the arc and the other independent of it; should the arc become too long its resistance will increase, and a larger proportion of the current will pass into the shunt, while the thicker wire helix will diminish in magnetic strength, and the resultant influence upon the core I C will be reduced and the upper carbon brought nearer to the lower. On the other hand, if the arc becomes shorter and its resistance reduced, more current flows through the primary coil and less through the secondary, and the carbons are drawn further apart.

The short-circuiting apparatus consists of an electro-magnet, C O, wound with thick and fine wire coils similar to those of the regulating coil F C, but both are wound in the same direction. When the thick-wire circuit of this magnet is complete it forms a shunt of less resistance between the terminals, and therefore short-circuits the lamp, transmitting the current to the main circuit. As the fine wire of this magnet is in circuit with the fine wire of the regulating solenoid F C, it follows that through a failure of the arc, or through any considerable increase in its resistance, a larger portion of current will be diverted through the fine-wire circuit, and the attractive force of the electro-magnet C O will raise the lever K pivoted on the centre *l*, making contact at *k*, and thus short-circuiting the lamp through the thick coil of C O and the resistance spring S, by a path altogether independent of either the fine or thick wire solenoids; and as then their magnetic action ceases the upper carbon drops, or if it is burnt out, or from any other cause the arc is not established, the contact pieces, *k*, remain firmly held together by the attraction of the electro-magnet C O, and the current flows past the faulty lamp to the others in the series. The Brush carbons are a foot long, and are electro-plated with a thin coating of copper. In the double carbon lamp the change from one pair of carbons to the new pair is effected by an ingenious mechanical contrivance, dependent upon the action of the sucking coil which raises the clutch on the carbon rod. By the simple device of placing one pair of jaws a little higher than the other it takes its grip before the other begins to act, and consequently lifts its corresponding carbon higher than its neighbour, so that only one arc is established across the lesser distance, and in all subsequent regulation the lower end of the reserve carbon is always higher than the other by the difference in the height of the two pairs of clutches. When the ends of the first carbons no longer meet where the frame is dropped, the current by which they are again separated can only be transmitted by the reserve carbons coming into contact; the circuit is then completed, and the new carbons come into action.

The Pilsen lamp, invented by Pielte and Krizik, is worthy of especial attention, because the light is regulated without any further mechanism and without the application of any other forces than the magnetic attractions due to the current

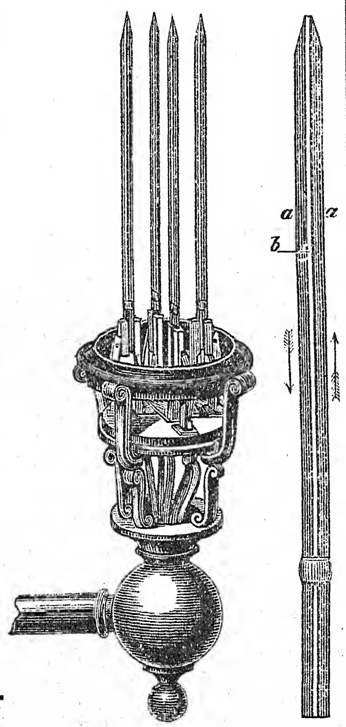
itself. The current before entering the lamp is divided into two parts, each of which traverses one of the two superposed solenoids M and M′ (fig. 3), in which an iron rod of peculiar shape, being thickest in the centre and diminishing gradually towards the ends, slides up and down. The main current traverses first the solenoid M, constructed of thick wire, while the shunted current traverses the solenoid M′, composed of a number of coils of very fine wire. The relation between the resistance in the solenoid and the length of the coil is calculated in such a manner that as soon as the arc attains a fixed and determined resistance the iron rod remains in equilibrium under the influence of the two solenoids. When the resistance increases the equilibrium is broken, and an adjustment of the carbons takes place. The carbon might therefore be fixed directly to the iron rod, if the attraction of the solenoids remained the same for each position of the rod; but this is not so, for when an iron rod penetrates into a solenoid traversed by a current, the attraction on the rod is at its maximum when the end of the rod is at the same level as the middle line of the solenoid. As soon as the rod advances beyond that line the attraction gradually decreases, and is at zero when the middle of the rod coincides with the middle of the solenoid. In the Pilsen lamp this difficulty is overcome by giving to the iron rods a peculiar elongated form, some of which are represented in fig. 7, Plate XXVII. By using iron cores of this description the attractive power of the solenoid remains the same for almost one half of the rod, as the different diameters of the rod compensate the differences in the attractive power of the solenoid. This regular motion of the rod enables the upper + carbon to be attached directly to the rod without the intervention of mechanism. The iron rod is suspended from a pulley, R, and counterbalanced by the weight W. The primary current enters the solenoid M through the conducting wire, passes through the + carbon, the voltaic arc, and the − carbon, and so on to the main wire again. The shunted current traverses the lower solenoid M′, and also returns into the main circuit outside the lamp. For a given resistance of the arc the rod is maintained in equilibrium by the two solenoids.

Fig. 3.



Pilsen Lamp.

Fig. 4.



Jablochkoff Candle.

As the resistance of the arc augments by the combustion of the carbons, the attractive force of the solenoid M′ in the shunted circuit increases, and the + carbon descends with the iron rod. The two solenoids are superposed at such a distance that the space between their centres is equal to half the length of the iron core. The action of the solenoid M in the main circuit is to separate the carbons; that of the shunt solenoid M′, to bring them together. If the current should be interrupted the carbons remain separated, as they are balanced by the counterpoise W. In such a case, when the current passes, it can only traverse the shunt solenoid M′, by which the carbons are at once brought into contact and the arc established. Should the carbons not be in contact, and several lamps have to be lighted in the same circuit, the current can only pass through the shunts, but then the resistance becomes too large, and the lamps cannot be lit. To meet this contingency each lamp is provided with an automatic commutator, which, before the carbons actually touch, sends the current into a spiral of thick wire having a coil of fine wire at the lower end; as soon as the carbons touch, this supplemental coil is put out of the circuit.

In this description of the arc lamp only a few varieties, and those the most practical, have been noticed. The large number of arc lamps brought forward only point out the extent of the area for inventive enterprise; it is the select few, however, that come into practical use.

The "electric candle" is an arrangement in which the two carbons are placed parallel to each other, and not end to end. It was the invention of a Russian officer, Jablochkoff, in 1876, and from its extreme simplicity and the complete absence of any mechanism, has attained a well-deserved success. In fig. 4 the two carbons, *a a*, are seen placed side by side, and insulated from each other by a thin strip of china clay (kaolin), *b;* on the current being sent through the carbons, the insulating strip maintains the arc at the extremity of the candle, but volatilizes in proportion to the combustion of the carbon. In order that both carbons may be consumed equally, the electric candle is exclusively fed by machines which continually reverse the direction of the current. For the purpose of lighting, a small piece of graphite is placed between the ends of the two carbons secured by a ribbon or paper, which establishes a conducting circuit. On the current passing the little piece of graphite becomes red hot and is consumed, when the voltaic arc appears, and is maintained as long as the candle lasts. The Jablochkoff candle has been extensively employed for lighting. In Paris upwards of 2500 of these candles have been in use for street lighting, generally arranged, as shown in the figure, so that as each candle is consumed another is lighted. The only disadvantage of the candle is the incessant variation of tint and brilliancy, arising from impurities in the carbon, but this defect may ultimately be lessened by improvements in the manufacture.

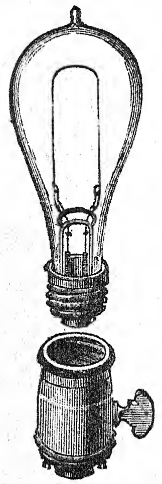
Light produced by the voltaic arc implies a longer or shorter distance between the two conductors; this space is occupied by gas raised to a very high temperature, and by particles of carbon detached from the electrodes. In electric lighting by incandescence two different principles are employed—incandescence with combustion, and incandescence alone. In the first the light is produced by a carbon point traversed by the current, and more or less quickly consumed. In the second the current passes through a substance of small conducting power, which becomes luminous without the substance being destroyed.

In the Joël Werdermann lamp, the light is produced by the heating to incandescence of the end of a small rod of carbon forming one electrode, which is pushed through a pair of hinged contact jaws by the action of a weight suspended by pulleys against a fixed cylinder of copper forming the other electrode. The carbon pencil is consumed at the rate of $2\frac{1}{2}$ to 3 inches per hour for lights of 100 candle-power, and rises according to its consumption. The length of the carbon point in circuit between the jaws and the fixed electrode is about three quarters of an inch, and it is rendered highly incandescent chiefly at that part of the pencil which becomes pointed in contact with the copper electrode. In addition to this a glow or flame appears from the sides of the incandescent carbon to the copper electrode. The light

takes an intermediate position between the purely incandescent system and that of the voltaic arc. The fixed electrode remains intact without any appreciable wear. With this lamp an illuminating power of 715 candles can be obtained per horse-power.

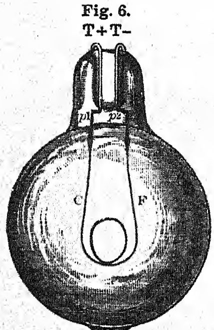
Lamps with incandescence alone are constructed on the principle of raising the temperature of a moderate but infusible conductor by the passage of a powerful current of electricity. If a substance possessing a very high point of fusion is employed, it may be raised to a very high temperature. The substances chiefly used for the production of light by incandescence are platinum, an alloy of platinum and iridium, iridium, and carbon. Edison's incandescent platinum wire lamp consists of a spiral platinum wire. To prevent the fusion of the wire a metallic rod is placed inside the spiral and heated by it, and on the principle of the pyrometer, at a certain temperature it expands, and establishes a direct short circuit between the two terminals of the lamp, and so weakens the current traversing the spiral. As the spiral cools, the metallic rod contracts and breaks the short circuit, the current again flowing through the spiral, and the same action again taking place. As the heating and cooling are very rapid, this form of incandescent lamp is in a continual state of electrical vibration. In order to overcome these objections, Edison subsequently adopted a specially prepared carbon filament produced from bamboo, and this carbon constitutes the very essence of his invention, which was patented in 1879, and subsequently in 1880. To prevent this filament from burning away when heated it is inclosed in a glass bulb from which the air has been very thoroughly exhausted. The exhaustion in the lamp is so complete that the pressure inside does not exceed the one-hundred-thousandth part of one atmosphere. The general appearance of the lamp is shown in fig. 5.

Fig. 5.



Swan's incandescent lamp was invented earlier than Edison's, but has only given good results since improvements have been made in the preparation of the carbon filaments. Fifteen lamps can be fed by one horse-power, and they give a brilliant light nearly the colour of gaslight. The preparation of the filaments is entirely different from that of the Edison carbons. They consist of threads of cotton about 10 centimetres in length, with ends thickened by winding additional cotton round them. These threads are immersed in dilute sulphuric acid, one part acid to two parts water, and after a certain time they assume the hardness and density of parchment. They are then placed in an earthenware crucible filled with carbon dust, the crucible is hermetically closed and raised to a white heat for a certain time, after which the carbons are placed in the lamps, which are then exhausted by a Sprengel pump, and the carbons are electrically heated to incandescence to drive out the gases before the final closing of the bulb. The filament has now become very hard and compact; its resistance varies from 30 to 100 ohms, and the light it gives varies from 15 to 20 candles. The most recent form of lamp is that shown in fig. 6. The exterior is entirely of glass, and from the short stem at the top project two platinum loops T+ and T−, the terminals of the platinum wires p^1 p^2, carrying the carbon filament C F. The lamp connection consists of an ebonite stud with a screw plug for attachment to a bracket or other stand. On each side of the stud are the binding screws, and in connection with them two small platinum hooks projecting from the stud, which hook into the loops T+ and T−; a short spiral spring fixed to the top of the ebonite stud maintains the contact between the platinum loops and the stud hooks. Various forms of incandescent lamps, such as the Lane-Fox, Maxim, and Crookes, have been constructed, all similar in principle to those above described. In general the resistance of incandescent lamps varies, according to the size and length of the filament, from 3 to 200 ohms. The current necessary to heat the filaments white-hot is usually from 1 to 1·3 amperes. To produce this current the electro-motive force that must be applied is dependent on the resistance of the lamp. If a lamp has a resistance of 80 ohms when cold and 60 ohms when hot, the required current will be obtained by applying an electro-motive force of about 60 volts, as $80 \div 60 = 1·3$ ampere. Well-made lamps, if not overheated, will last about 1200 hours before the filaments disintegrate. Incandescent lamps are usually grouped in parallel arc on shunts between the leading main conductor and the return main, so that each lamp is independent of the others if the electro-motive force of the supply is constant.

Fig. 6.
T+T−



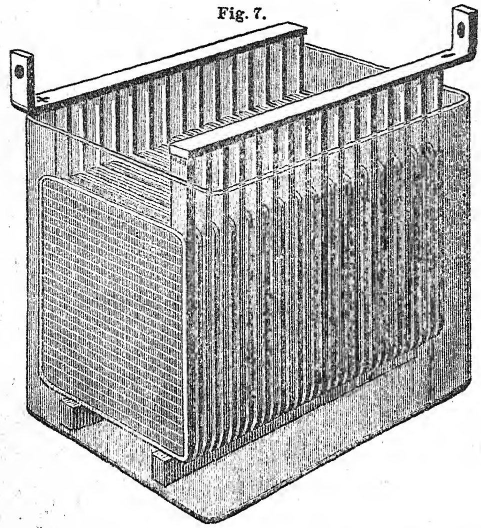
The incandescent lamp, though not the most economical, is the best adapted to the uniform distribution of the electric light, and from its colour and the absence of strong shadow its light is certainly the most agreeable. The applications of the electric light daily assume more importance, from the powerful light of lighthouses, equal to 30,000 candles or more, to incandescent lights scarcely attaining one-tenth of a candle, employed in surgery for illuminating obscure cavities.

The employment of batteries for electric lighting is excessively restricted, being confined to the lecture room and the laboratory. This arises not only from the expense, but also from the difficulty of manipulation of a large number of elements in series. Although the secondary battery is not an electric generator, it now renders service in several special applications, and may be employed where only a short period of lighting is required. Ritter was the first to demonstrate that a battery might be constructed of plates of metal of the same kind (as platinum), and that if a piece of moistened cloth is interposed between each pair, and each end of such a system is connected with the poles of a battery, after a time the apparatus, when separated from the battery, can itself produce all the effects of a voltaic battery. Such a battery is termed a *secondary battery*, and its action depends on an alteration of the surface of the metal produced by the electric current due to the polarization already explained.

Planté was the first to show the practical importance of the secondary battery. His element consisted of a broad sheet of lead with a tongue, on which was laid a second similar sheet, contact being prevented by narrow strips of felt; the sheets are then rolled up together to form a compact cylinder. This is placed in a vessel containing dilute sulphuric acid, and is connected, by wires attached to the two tongues, with a battery of two Grove's cells. On a current being passed through it the water is decomposed, oxygen being liberated at the anode or plate corresponding to the +pole, and there uniting with the lead, forming peroxide of lead, while hydrogen is accumulated at the cathode. When the plates are separated from the charging battery and are connected with each other, a powerful polarization current is produced in the opposite direction to that of the primary. The oxygen of the peroxide at the anode decomposes the dilute acid, combining with its hydrogen, and ultimately reaching the other plate, where it combines with the lead. The activity of the element increases with repeated charges. The plates may remain for many days charged, and will continue to furnish a current until the two lead surfaces are reduced to a chemically inactive state. The electro-motive force of such cells may attain from 2·10 to 2·25 volts. Batteries of such cells arranged so that they can be charged in parallel arc and discharged in series, give for a limited time currents of extraordinary strength. So long as such batteries could only be charged from a voltaic battery they could never be economical; but the fact that they retain the charge for a considerable time, has led to their use as storage batteries of electricity produced by mechanical power through the agency of dynamo and magneto-electrical machines. Faure, in 1881, improved the Planté accumulator by coating

over the surfaces of the two lead plates with minium or red lead. When a current is passed through the cell to charge it, the red lead is peroxidized at the anode and reduced first to a condition of lower oxide, then to the spongy metallic state at the cathode, and thus a greater thickness of the working material is provided in far less time than is the case with the Planté cell. For the purposes of electric lighting, Faure's cells are made up with flat plates arranged in vertical parallel series in boxes, as shown in fig. 7.

Fig. 7.



A secondary cell resembles a Leyden jar in that it can be charged and then discharged. Its time of leakage is also similar, but what it really stores is not electricity, but the products of electro-chemical decomposition, which products remain capable of yielding a current on their recombination. The size of these batteries and their storing capacity has of late been increased to such an extent that they have been successfully employed for the illumination of large buildings.

At the Grand Hotel, Charing Cross, London, for the feeding of eighty Swan lamps for six hours, eighty Faure accumulators had to be charged during fourteen hours by two Edison dynamos. As each of these machines would feed sixty Edison lamps of nine candles each by supplying the lamps direct from the machines, 120 could be fed during fourteen hours by the same mechanical work which supplies eighty lamps during six hours only. The direct employment of dynamo-electric machines gives therefore an illumination one and a half times greater in intensity, and two and a third times longer in duration. Storage batteries can only give back, with a certain loss, the electro-motive force which they have received through a generator, and as a transformation of force cannot be effected without loss of energy, the employment of accumulators for electric lighting is always at a disadvantage.

The first lighthouses lighted by electricity in France were those of Cape la Hève, in December, 1863. Since that time all the more important French lighthouses have followed; and several in England, more notably the South Foreland, Souter Point, the Lizard Point, and Dungeness lighthouses.

For the illumination of steam vessels electricity can be economically produced, and the large steamship companies are rapidly introducing electric light for the illumination of their saloons and cabins. The Inman Company's steamer, *City of Richmond*, was the first vessel which was so lighted —with the Swan lamp.

Not only for mercantile shipping, but also for the navy, the electric light is now of the greatest importance. The powerful ironclads have called into existence an enemy of equal power, the torpedo and torpedo-boat, a small steam launch of the highest attainable speed, which tries to launch the torpedo against the hull of the vessel without being detected. It is therefore indispensable for ironclads to have the electric light at command, so as to explore and sweep the horizon in order to discover the approach of a torpedo launch at night.

This light is now employed on certain railways for the lighting up of the carriages by the incandescent lamp. It is also largely employed for the illumination of railway stations, dock quays, factories, workshops, public buildings, theatres, thoroughfares, &c. The reading-room of the British Museum has been fitted with the light. The electric lamp is also employed for submarine work, laying the foundations of lighthouses, bridges, &c. The electric light has been used in surgery by Sir Henry Thompson to explore the bladder, and Leitz of Vienna and Payne of London devised instruments for illuminating the bladder, uterus, and throat. The apparatus consists of a brass tube, electro-plated, $9\frac{1}{2}$ inches long and $\frac{11}{16}$ inch diameter; one end of the tube is funnel-shaped, the other closed by a piece of glass. A Swan lamp is used, hermetically sealed in a glass shade, and kept cool by water circulating round the lamp through very fine brass tubes. For prolonged observation a Bunsen battery is used.

INDUCTION CURRENTS—MAGNETO-ELECTRICITY.

The discovery by Faraday, in 1831, that currents may be induced in closed circuits by moving magnets near them, or by moving a closed circuit across a magnetic field, was speedily followed up by finding that a current whose strength is changing may induce a secondary current in a closed circuit near it. Such currents are termed *induction currents*, and the currents producing them *inducing currents*. When a current is sent through a wire it induces a momentary current of electricity in a second wire forming a complete circuit and placed parallel to it, both when contact with the battery is made and when it is broken; but while the electricity continues to flow through the first wire, no inductive effect is produced on the second wire. The direction of the induced current on breaking battery contact is in the same direction, and on making contact in the reverse direction, of that of the inducing current.

When two helices of insulated wire, $a\,b$ and $c\,d$ (fig. 8), are wound round an iron ring and separated at M and M′ by about half an inch of uncovered iron, a current of electricity sent through one helix, $a\,b$, induces a current in the second helix, $c\,d$; on the making and breaking contact with the battery, and if the current is powerful, a small spark may be seen between charcoal points placed at $c\,d$ at the moment of making contact, but never while a continuous current is passing through $a\,b$. When a coil of insulated wire, $a\,b$, fig. 9, is connected in circuit with a delicate coil galvanometer, and a magnet, N S, is rapidly inserted into the hollow of the coil, a momentary current is induced round the circuit while the magnet is being moved into the coil. So long as the magnet remains stationary no current is induced, but on rapidly withdrawing it from the coil a second momentary current is induced in the opposite direction. The induced current on inserting the magnet is an *inverse* current, and is in the opposite direction to that which would magnetize the magnet with its existing polarity. The induced current caused by the withdrawing is a *direct* current. If, instead of the magnet A B, a smaller coil of stout wire, B (fig. 10), is connected to the poles of a battery so as to be traversed by a current, on inserting the smaller or primary coil into the larger or secondary coil, A, a momentary inverse current is produced, and on removing it a momentary direct current is observed. Breaking the battery circuit of the primary coil while it lies within

Fig. 8.

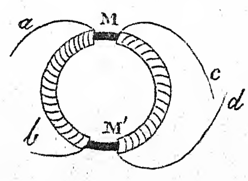
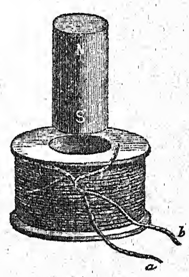
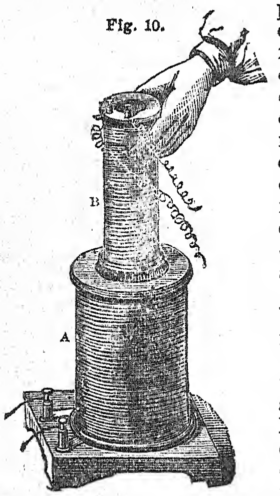


Fig. 9.



the secondary outer coil produces precisely the same effect as if the primary coil were suddenly removed, and closing the battery circuit produces the same inductive effect as suddenly plunging it into the secondary coil. So long as a steady current traverses the primary coil there is no inductive effect upon the secondary coil, unless there is relative motion between the two circuits; but moving the secondary circuit towards the primary coil produces the same effect as moving the primary circuit towards the secondary, and *vice versâ*.

Fig. 10.



As every circuit traversed by a current has a field of magnetic force of its own, in which there are lines of force running through the circuit, a coil of many turns of wire has a field in which the lines of force are almost identically distributed as those of a magnet. The fundamental laws of induction may therefore be stated to be as follows, the distance remaining the same:—

LAWS OF INDUCTION.

1. A continuous and constant current does not induce any current in an adjacent conductor.

2. A current at the moment of being commenced produces in an adjacent conductor an inverse current.

3. A current at the moment it ceases produces a direct current in an adjacent conductor.

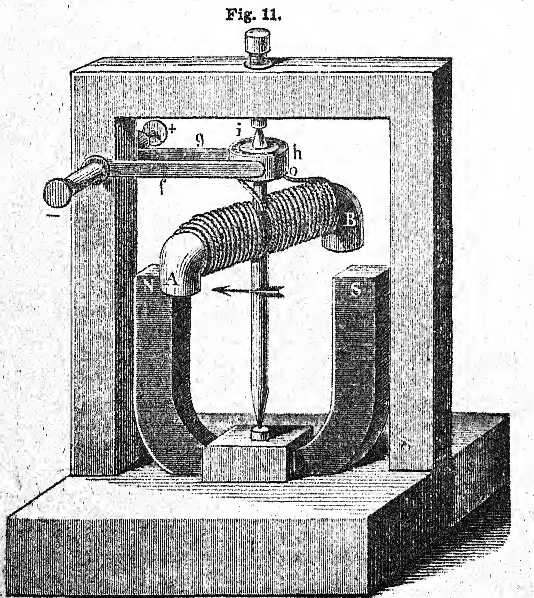
4. A current whose distance is increased or whose intensity diminishes gives rise to a direct induced current.

5. A current whose distance is diminished or whose intensity increases gives rise to an inverse induced current.

Lenz has based the following law on the induction produced between a closed circuit and a current in motion—that in all cases of electro-magnetic induction the induced currents have such a direction that their reaction tends to arrest the motion which produces them.

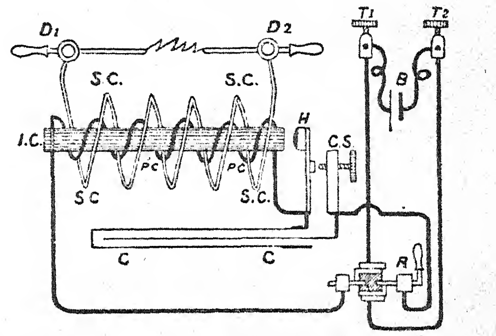
Induced currents of great power are produced when a coil of insulated wire wound upon a soft iron armature, A B (fig.

Fig. 11.



11), is caused to revolve before the poles of a permanent magnet, N S. The make and break piece, *h*, called the commutator, interrupts the current by means of the two springs, *fg*, pressing alternately upon two ivory pieces, *i o*, so that the make and break of contact is at the moment of the approach and recession of the armature and coil before the poles of the magnet. Induced currents have, as a rule, very high electromotive forces, and are able to produce sparks across spaces that ordinary battery currents cannot traverse. The induction coil improved by Ruhmkorff is an apparatus by which the spark may be observed. It consists of an iron bar, or bundle of wire, I C (see theoretical diagram fig. 12), as a central core, round which is wound a short inner or primary coil, P C, of stout wire, surrounded by an outer secondary coil, S C, consisting of several thousand turns of very fine wire carefully insulated from one another. The primary coil is connected to the terminals of a powerful Grove or

Fig. 12.



Bunsen battery, B, and in the circuit are also included an interruptor, H, and usually a condenser, C C. The object of the interruptor is to rapidly make and break the primary circuit, and at every make to induce in the outer secondary circuit S C a momentary inverse current, and at every break a powerful momentary direct current. The currents at break manifest themselves as a brilliant succession of sparks between the ends of the secondary wires D^1 and D^2 when brought sufficiently near together. In the late Mr. Spottiswoode's great induction coil, which, with thirty Grove-cells, gave a spark of $42\frac{1}{2}$ inches in air, the secondary coil contained 280 miles of wire in 340,000 coils, with a resistance of over 100,000 ohms.

The interruptors of induction coils are generally self-acting, consisting of a piece of thin steel which makes contact with a platinum pointed contact screw C S, and which is drawn back by the magnetic attraction of the iron core on the passing of a current; and thus makes and breaks circuit by vibrating backwards and forwards. The small condenser C is made of alternate layers of tinfoil and paraffined paper arranged like a Leyden battery, into which the current flows whenever the circuit is broken. The object of the condenser is to make the break of circuit more sudden by preventing the spark due to self-induction in the primary circuit from leaping across the interruptor, and also to store up the electricity of this self-induced extra current, so that when circuit is again made the current shall attain its full strength more rapidly than it would otherwise do.

Induced currents are also produced when a magnet is moved near a solid mass or plate of metal, and these currents in flowing through it from one point to another have their energy gradually converted into heat. They also produce, in accordance with Lenz's law, electro-magnetic forces tending to arrest the motion.

Arago observed in 1824 that when a copper disc is rotated in its own plane under a magnetic needle, the needle turns round and follows the disc; and if a magnet is rotated beneath a balanced metal disc, the disc follows the magnet. Faraday showed that these effects were due to induction. The variations of the earth's magnetism induce in telegraph circuits disturbances which are known as *earth-currents*. Such currents frequently attain a greater strength than the ordinary working currents. Feeble earth-currents are constantly observed on the circuits, and are more or less periodic in character.

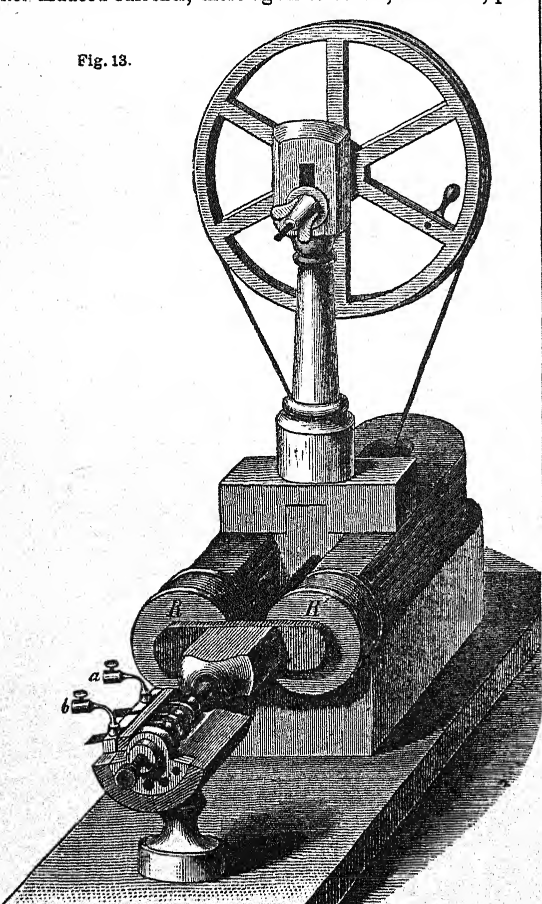
Self-induction in a circuit is attested by the so-called extra current, which appears as a bright spark at the moment of breaking contact. When the circuit is a simple one, consisting of a straight wire and a parallel return wire, there is little or no self-induction; but if the circuit be coiled up, especially round an iron bar, as an electro-magnet, then on breaking circuit there will be a brilliant spark, and if the two ends of the wires between which the circuit is broken are held in the hands, a slight shock is experienced, arising from the high electro-motive force of the extra current, caused by the inductive action of the current in each coil upon the adjacent coils. On making circuit this extra current, due to self-induction, is an inverse current, and gives no spark, but it prevents the battery current from reaching at once its full value. The extra current on breaking circuit is a direct current, and increases the strength of the battery current just at the moment when it ceases altogether. The following are the laws of the extra current:—

(1) The intensity of the currents employed being the same, the extra currents obtained on the breaking and making have the same electro-motive force.

(2) The electro-motive force of the extra current is proportional to the intensity of the primary current.

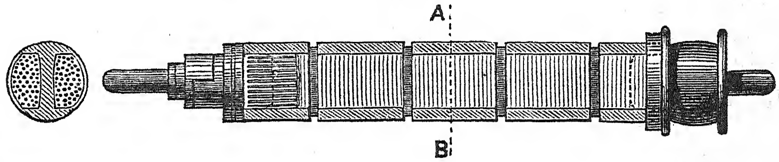
Notwithstanding their instantaneous character, induced currents can, by their action on closed circuits, give rise to other induced currents, these again to others, and so on, pro-

Fig. 13.



ducing induced currents of different orders. The currents thus produced are alternately in opposite directions, and their intensity decreases in proportion as they are of a higher order. Induced currents have all the properties of ordinary currents, and are capable of producing physiological, calorific, luminous, and chemical effects. They likewise deflect the magnetic needle, and magnetize steel bars when they are passed through an insulated copper wire coiled in a helix round the bars. The action of the direct and the inverse induced current upon the galvanometer needle is about the same; but the shock of the direct current is very powerful, that of the inverse current being scarcely perceptible.

Fig. 14.

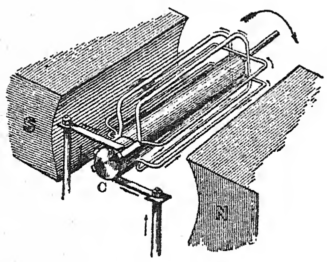


The discovery of the induction of currents in wires by moving them across a magnetic field, suggested the production of an interrupted series of sparks by means of a magnet, and the generation of currents, in place of using voltaic batteries. Various forms of apparatus for this purpose were devised by Pixii, Ritchie, Saxton, Clarke, and others, consisting of bobbins of insulated wire fixed to an axis and revolved rapidly in front of the poles of strong steel magnets. As the currents thus generated were alternately inverse and direct currents, a commutator, which rotated with the coils, was fixed to the axis to turn the successive currents all in the same direction. Such a machine generally consists of a powerful horse-shoe plate magnet fixed upon a wooden support. In front of the poles are two bobbins, R R′ (fig. 13), movable round a horizontal axis. The bobbins are coiled on two cylinders of soft iron joined at one end by a plate of soft iron, at the other by one of brass. These two plates are fixed on a brass axis, terminated at one end by a commutator and at the other by a pulley, which is moved by an endless chain passing round a large wheel, turned by a handle. Each bobbin consists of about 1500 turns of fine insulated wire. One end of the wire of each bobbin is connected with the axis of rotation, and the two other ends of these wires terminate in a brass washer, which is fixed to the axis, but is insulated by a piece of ivory. In order that the induced currents may be in the same direction, the wire is coiled on the bobbins in reverse ways. When the armature revolves its two branches become alternately magnetized in contrary directions under the influence of the magnet, and in each bobbin an induced current is produced, the direction of which changes at each half turn. By means of the commutator the two alternating currents are always brought into the same direction, and sent through the terminals *a b*. Wheatstone devised a compact form of magneto-electric machine producing a powerful induced spark for firing mines and fusees. All these machines, and others based on the same principle, only produced feeble currents, and their application was therefore very limited. In 1849 Nollet of Brussels constructed a Clarke's machine on a large scale, which afterwards being transformed by Masson into an alternating current machine constitutes the generator now known as the Alliance.

In 1854 Siemens and Halske of Berlin made a great advance by the introduction of the coil which bears their name. It consists of a soft iron cylinder, with two longitudinal grooves parallel to its axis, which give it in transversal section the form of a double T, as shown in fig. 14. An insulated copper wire is wound into the grooves, and the ends of the wire are fixed to the two halves of a commutator for the collection of the currents, as in Clarke's machine. On turning the coil rapidly between the poles of a magnet, induction currents are produced in the wire; these currents are afterwards collected, as shown in diagram (fig. 15), which, for the sake of clearness, gives only one or two of the wires. The arrows show the direction of the induced currents, while N and S represent the poles of the magnet, and C the *commutator* by which the currents are led off in one contant direction. In all electric generators with continuous currents the machines are reversible; that is, if they develop electricity by expending work, they can also produce work by expending electricity. Between

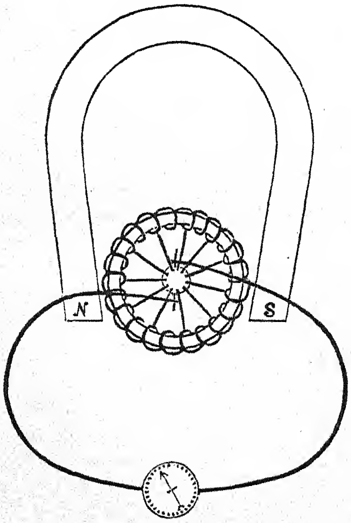
Siemens' coil of 1854 and Gramme's ring of 1870, an invention which has given a most powerful impetus to the production of electricity by mechanical means, various new principles were introduced. In 1867 Wilde made use of electro-magnets instead of permanent magnets as inductors. As an electro-magnet has fully twenty-five times as much power as a steel magnet of equal weight, the intensity of the magnetic field, and consequently the intensity of the resulting current, were largely increased. The next great advance was made in a new principle discovered simultaneously by Sir C. Wheatstone and Dr. Werner Siemens, and consists in the gradual increase of intensity of an electro-magnetic system under the influence of the induction currents which it develops. The merest trace of residual magnetism is sufficient to produce a current with accompanying magnetizing effects on the electro-magnets, increasing up to a certain maximum, which will depend on the speed of rotation of the coil, the resistances of the circuit, and the point of magnetic saturation of its inductors. Thus the use of permanent magnets in those machines was shown to be unnecessary.

Fig. 15.



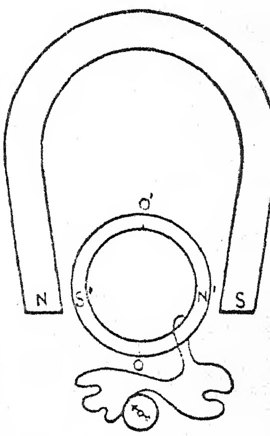
Whatever is the shape of the part which receives the current, dynamo-electric machines may be divided into three classes, according to the way in which the field-magnets are charged. In the first group the inductors are charged by a distinct and perfectly separate circuit fed by a special machine, which frequently feeds not only one but several machines. In the second group the electro-magnets forming the magnetic field are arranged in the same circuit as the armature and external circuit. This is the arrangement invented by Wheatstone and Siemens in 1867, and which is now applied to nearly all modern dynamo-electric machines. The magnetic field depends therefore on the strength of the traversing general current. The third group was also invented by Wheatstone, and consists in placing the electro-magnets in a shunted, and not in the same circuit. In this arrangement these magnets are coiled with a long wire of considerable resistance. Such machines are much more regular in the strength of the current produced.

Fig. 16.



The most important progress in the mechanical production of electricity since Wheatstone's discovery is due to Gramme. By his machine the applications of electricity to lighting, electro-plating, and the transmission of motive force have made very rapid strides of late. Gramme's machine is the first effective magneto-electric machine constructed to give continuous currents all flowing in the same direction. In its simplest form (fig. 16) the armature invented by Pacinotti, and subsequently by Siemens, consists of a ring of soft iron, wound with a single closed coil of copper wire insulated except at a single point in each coil, which is left uncovered in order to make contacts. The ring (fig. 17) is placed between the poles (N S) of a permanent or electro-magnet. The portions of the ring contiguous to the poles acquire therefore a polarity of the opposite kind to that of the adjacent pole, while the portions of the ring O O′ at the end of the diameter at right angles to a line joining the poles will be neutral. When the ring is made to revolve rapidly on an axis perpendicular to the plane of the fixed magnet, the poles of the ring as well as the neutral points become slightly displaced in the direction of the motion. This arises from the coercive power of iron; that is, the iron will neither acquire nor lose its magnetism instantaneously. If it is supposed, to understand the action of the coil, that there is only one loop of wire on the ring, and that this loop is movable and in connection with a galvanometer; if the loop is moved along the ring, assumed to be at rest, from the neutral line O towards S′, a current will be developed in a certain direction, which will increase in intensity till the loop reaches S′, when the current, still flowing in the same direction, will diminish as the loop arrives at O′, when for a moment it falls to zero, to be succeeded by a current in the opposite direction as the loop leaves O′, and moves towards N′, where it again attains its maximum, and once more diminishes as the loop passes on to O, where it is again at zero, the direction of the current again changing as the loop passes on to S′. There is therefore a current always flowing in one direction as the loop passes from O through S′ to O′, and in an opposite direction as it moves from O′ through N′ to O. If instead of the loop being movable upon the ring, it is firmly attached to it, and the ring be rotated on its axis in the plane of the fixed magnet N S, the currents developed will correspond both in direction and intensity with those produced in the movable loop, always allowing for the small displacement in the position of the poles of the ring arising from its rotation. This action of a single loop applies to any number of loops forming part of a coil extending over the whole iron ring. Each loop of such a coil will give a current in one direction during one half of every revolution, and a current in the opposite direction during the other half, and the electro-motive force thus developed will augment with the number of loops in the coil.

Fig. 17.

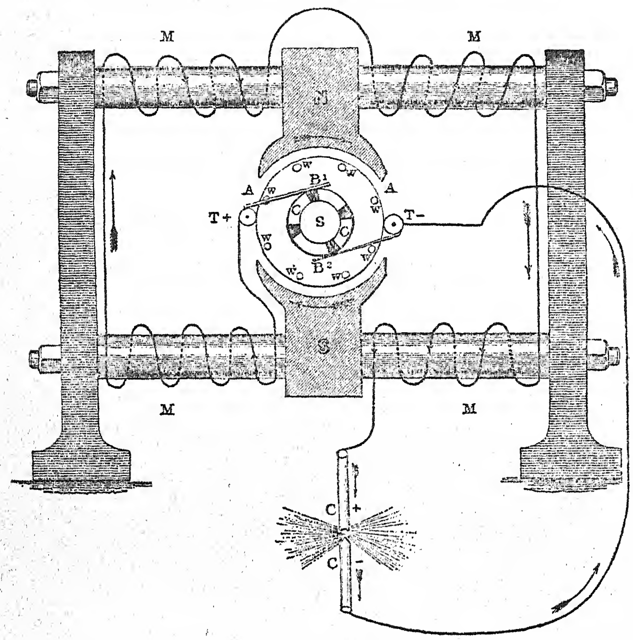


For the purpose of obtaining currents of high intensity, the single coil is replaced by a number of coils of thin wire wound one above the other and carefully insulated. To carry off the current these coils are divided into separate helices, with the adjacent terminals of the wires of the helices in metallic connection; the iron ring is therefore surrounded by an endless conductor of great length. By simplifying his invention more and more, Gramme has finally succeeded in constructing a machine with two electro-magnetic bars and one central ring similar to the diagram (fig. 18), in which, however, the plane of rotation of the armature is at right angles to its actual plane in the machine as constructed. M M are the electro-magnets, S the ring armature, of which W W are the wires (only one or two shown), and B^1 B^2 the brushes of the

commutator which collect the electricity and convey it to the carbons c+ and c−. Gramme's machine in its present form transforms, under favourable conditions, 85 to 90 per cent. of the work expended into electricity.

In Siemens' dynamo machine, invented by Hefner Alteneck, a cylindrical armature is employed. The induction coil, formed of sections connected with one another and with a Gramme collector, is of considerable length and coiled in a special manner, the wire only covering the external part of the supporting frame. The induction is therefore only produced by the exterior face, which is presented to the inductors, and the thin iron frame which replaces Gramme's wrought-iron ring

Fig. 18.



plays a very subordinate part. The coiling of the wire is therefore much easier, and the coil can be fixed and centred on its axis of rotation in a much simpler manner. The number of new machines for producing continuous currents increases almost daily, and it is impossible to describe them all in detail. Experience alone will enable the really practical inventions to be selected from among so many.

In the machines mentioned above each coil was traversed alternately by two or an even number of currents in opposite directions. These currents were collected in the external circuit, so as to obtain them always in the same direction, and to produce a continuous current. In certain other machines the currents are collected without this precaution; such machines are termed alternating current machines, and are divided into two classes, like the continuous current machines: (1) machines with permanent magnets, and (2) machines with electro-magnets. In the electro-magnetic machines of Pixii, Clarke, Siemens, &c., it is only requisite to suppress the inverting commutator, and to replace it by a simple collector, in order to obtain apparatus with alternating currents, whose power will depend on the intensity of the magnetic field, the velocity of rotation of the coils, their dimensions, number, &c.

Dynamo-electric machines differ from *magneto-electric* machines in the nature of the inductors, which with the former are electro-magnets, while permanent steel magnets are used for the latter. In continuous-current machines the current of the machine itself is used for the magnetization of the inductors. This cannot, however, be done with alternating currents; it follows therefore that to constitute a dynamo-electric machine with alternating currents, two machines are required: one of them, the exciting, inducing, or magnetizing machine, is of comparatively small size, and is employed for charging the electro-magnets of the second, which is called the distributing, division, or light machine. This latter furnishes alternating currents in one or several circuits. Lontin, Gramme, and Siemens all employed two machines: an exciting machine with continuous currents, and a division machine, but each system has its own distinctive characteristics of construction.

Machines which are worked without a distinct and separate machine are called self-exciting. The advantage of this arrangement is simplicity of transmission and construction, and also cheapness. Machines of this description have been constructed by Wilde, Gramme, Schuckert, De Meritens, Burgin, and Siemens. This last-named machine, which virtually constitutes a class of its own, has a long electro-magnet, with a core consisting of a number of iron plates, which form on both sides of the coil two hollow cylinders. Each of these hollow cylinders constitutes one of the poles of the electro-magnet; on the shaft in the interior of each cylinder are placed four copper plates, the extremities of each of which are connected with two ferrules insulated from the other bands. Each pole has therefore eight ferrules. Above these ferrules the collecting plates are fixed, which can be coupled either for tension or for quantity. A driving belt communicates to the two cylinders, formed of the copper plates inside the iron cores, a motion in the same direction. Sometimes the field-magnets of a dynamo-electric machine are wound with two sets of coils, so that it can be used as a combined shunt and series machine. Machines of this kind, when run at a certain "critical" velocity, yield a constant current, or give a constant electro-motive force, whatever the resistances in the circuit. Either of these results is obtained by combining in one case a shunt winding, in the other case a series winding, with an independent magnetization derived either from a permanent magnet or from a separately excited field-magnet.

Among the appliances which transform mechanical work into electricity are Bell's magnetic telephone and its numerous imitations. All magnetic telephones are electric generators, which under the influence of the mechanical work resulting from the vibrations which constitute sound, excite electric currents of an intensity proportionate to the amplitude of these vibrations. The most powerful and most feeble currents which can be produced have thus the same origin—in mechanical work.

LOGIC.—CHAPTER XIV.

METHOD—ITS NATURE, PRINCIPLES, PROCESSES, AND UTILITY.

All knowledge naturally tends to fall into logical forms. Logic is not an apparatus of technicalities through which, as into a series of moulds, all knowledge may be pressed; but a descriptive exhibition and exemplification of the path of transit, its bifurcations, its halting-places, its wicket-gates, and its terminus, along, by, through, and to which duly legitimated thought passes in its course from experience to science. As the science of the regulative principles of reasoned thought, it sees that we start fair, having our conceptions, whether mental or material, distinctly marked and clearly known. The conception is at once the real and the formal matter of thought; the name or term is only instrumental and representative. It does not hinder the elasticity and pliability of thought to insist that each idea shall tally with its name, and to take pains to discover to which category it belongs, and what part in predication it is capable of taking. Abstraction, division, definition, generalization, and classification are means of testing, arranging, and methodizing the elements of thought. If we are asked to attend to the quantity and quality of propositions, that we may learn to distinguish the right and the true from the untrustworthy and delusive, and be exactly certain of what we carry with us in thought to the public market-place of expression, the suggestion made and the object aimed at are surely neither trivial nor undeserving of regard. To subject the expression

of thought to investigative analysis and constructive synthesis, that we may see its several parts as elements and test their position as wholes, can scarcely be considered as unadvisable or superfluous. To acquire a knowledge of the formal conditions by which ideas become bound together into the definite certainties of truth and science—as syllogized conclusions of the reason—must, one would think, impart greater confidence to those who accept such certified conclusions than if these aids to certitude were neglected and unused, even though they may fail to put beyond possible or conceivable doubt the matter of thought. If science seeks certainty, and the mind's passion be for truth, everything which helps to systematize thought and secure such check and countercheck in investigation as experience and reflection have suggested, must be valuable and interesting.

The scientific supervision of the search and research to which curiosity and necessity alike impel man requires methodic thought. The speculative instinct, in its eagerness to attain an independent insight into the nature of things, must be controlled by the trained intellectual habit of exact investigation. Analogy co-ordinates for us the (probable) likeness of causes from sameness of phenomena, and the likelihood of similarity of effects from sameness of causes, and suggests to us hypothetical explanations which we may afterwards test by induction and retest by syllogistic inference. Parables, fables, and illustrations may not prove anything, but they suggest the logical process which runs parallel, and serve as a sort of sketch-route of the passage of thought along the steps of investigation. They exercise no dynamic power on the cogency of reasoning, but they smooth the way for the progress of thought in similar processes. Hypothetical reasoning accepts preliminarily—on the suggestion of analogy—the colligation or inductive ingathering of facts, or even as a mere explanatory guess of a premise not really made certain by proof, in order that from the consequences it involves an approach may be made, by appeal to experience, towards knowing whether the deduced results agree with the implied truth of the premise accepted. Every confirmation by experience of the causative efficiency of the principle hypothetically adopted, lends greater probability to the truth of a hypothesis, especially when unopposed by negative instances. Logic permits the utmost boldness of hypothetical imagining if it be carefully safeguarded by cautious accuracy in inductive criticism. As the science of the principles which lie embodied in all other sciences, logic looks out for the meeting-point at which individual facts supply the proof of principles. Where, after direct and indirect systematic critical experiment and reasoning, hypothesis rises to a high degree of probability, it is accepted as a theory, and then every phenomenon is reinvestigated in its light and by its power. If every act of research results in giving evidence insisting that the theory is right, and no resisting evidence appears to rebut that which has been diligently and impartially sought and examined, then the principle is accepted and registered among the accepted truths of science or philosophy.

And just in proportion to the balance—qualitatively and quantitatively—in favour or disfavour of a theory furnished by the consilience of facts, is the progress of a principle from possible, probable, highly likely, almost certain, clearly ascertained, to validly accepted truth. The proof of any principle deduced from presupposed (*i.e.* hypothetical) premises is direct, and as it increases in cogency, the mind accepts as more certain the coincidence of the principle accepted in thought with the real cause in nature or mind. Every direct deduction made from the principle substantiates the truth of the hypothesis which underlies it. The proof of any principle deduced from showing the incompetency of any opposing principle to account for the same facts, as it does, in a manner so consistent with all the facts and other accepted principles, is validly powerful in demonstration, and indirect though it is, it should invariably be employed in the scientific endeavour to obtain positive, or at least convincing, certainty of the truth of principles.

The principle sought may be regarded as a problem. To submit that to scientific investigation is to weigh the reasons for and against the proposition in which it may be most clearly stated. It thus assumes the form of a disputation. We seek proofs agreeing with the proposition stated, and consider them. But we must see that there is also due examination made of any antithesis to or contradiction of it—if any refutation is possible, either from incompatibility with facts, internal contradiction, insufficiency, or indeterminateness of statement, or too great breadth of inclusion. If it is constructed in a clear, definite, provable form, it must be free from contradiction, paralogism, or ambiguity—prove neither too much nor too little, assume nothing as true that is not (provenly) so, unless as an assumption, and must not include in itself that which is sought to be proved by it.

Science attains perfection only when the whole of the knowledge with which it concerns itself can be arranged in an orderly combination of principles holding a mutual relation each to each, and each to all, in such a way that, in its form, contents, and implications, all is compacted into a system of reasoned truths thoroughly demonstrated. Individual experiences are then explained by general principles, and general principles are substantiated by individual experiences. Making the former the starting-point of our reasoning, we can rise to the latter; and taking the latter first in order, we can descend to the former. Progressively from principles to experiences, or regressively from experiences by synthesis and analysis, the pathway of thought is levelled and made plain by methodic thought. In the unity of systematic thought analysis conditions synthesis, induction conditions deduction, and *vice versâ*. They are reciprocal and co-ordinate, and as such they insure the completeness and the totality of science. Science is the entire sum of the phenomena of experience aggregated into principles, including, classifying, and explaining all that is known and thought, so far as these are true. From the central conscious unity of human thought to the utmost verge of the explorations of experience logic goes, in the endeavour to discover all that is determinable in knowledge, and when it returns from the wide circumference of investigation to the mental centre, bringing with it the discoveries it has made regarding all the integral parts submitted to or brought under its inspection, the mind unites all these interdependencies into a system, the co-parts of which cohere into one sum of thought—science. As no single mind can realize and fill up, by and for himself, the entire universe of experience and reason, it has been felt necessary, in practice, to draw boundary-lines between the co-adjacent provinces of investigation, so that those who labour therein may employ their attention undistracted and entire in that specific department, may survey its contents and capabilities with every possible aid, and bring back trustworthy reports concerning all that is striking and true in them. Logic draws out the plan to be pursued by each subdivision of investigators, so that with uniformity and rigour each and all the discoveries may be readily reduced to oneness, and take their place in scientific conception. Every-day experience assures us of the existence and operation of laws of thought in our minds. Logic traces the relations and requirements of each of these to one another, and to the intellect in which they exercise power. Thus it is that the institutes of logic become regulative and take their place as the common basis of science—the method of thought.

CHEMISTRY.—CHAPTER XVII.

NORMAL SOLUTION OF HYDROCHLORIC ACID—NORMAL SULPHURIC ACID SOLUTION—NORMAL CAUSTIC SODA SOLUTION—LITMUS SOLUTION—ANALYSIS OF SODA-ASH—DETERMINATION OF AMMONIA—TABLES OF THE SPECIFIC GRAVITIES AND STRENGTHS OF SOLUTIONS OF SULPHURIC ACID, CAUSTIC POTASH, NITRIC ACID, AMMONIA, HYDROCHLORIC ACID, AND SODA—DETERMINATION OF STRENGTH OF ACETIC ACID, PYROLIGNEOUS ACID, AND VINEGAR, AND OF COMBINED CARBON DIOXIDE—ESTIMATION OF CARBONIC ACID.

THE volumetric process requires that the reaction which constitutes the basis of the method must be constant, and it further necessitates that an accurate means is available to determine the completion of the reaction. Therefore, in order to carry out a volumetric process, a solution of the reagent of known chemical strength, termed the *standard*

solution, is necessary; likewise the means of accurately determining the completion of the reaction; also accurate measuring vessels, termed pipettes, litre flasks, &c., and a graduated tube termed a burette for pouring determinate quantities of the standard solution into the liquid on which it is to act. The various standard solutions may be prepared as follows:—

Normal Solution of Hydrochloric Acid (1 cubic centimetre=0·03646 gramme HCl).—When a solution of hydrochloric acid containing 20·2 per cent. HCl is boiled under ordinary pressure, the acid and water distil over in the proportion in which they are contained in the boiling liquid. This principle is the basis of the method of preparing a standard solution of hydrochloric acid. The specific gravity of a strong solution of hydrochloric acid having been ascertained, water is added until its specific gravity is reduced to 1·1. A solution of this strength will contain about 20·2 per cent. HCl. The quantity of water, x, required to be added to a measured quantity of strong hydrochloric acid, A, of a specific gravity a, to reduce it to the specific gravity b, is found by the formula $x=\frac{A(a-b)}{b-1}$. For instance, if the specific gravity of the acid is 1·16, in order to bring its specific gravity down to 1·1 it will be necessary to add to every 100 c.c. of acid $\frac{100(1\cdot16-1\cdot1)}{1\cdot1-1}=60$ c.c. of water; 500 c.c. of strong acid are mixed with the necessary quantity of water to reduce its specific gravity to 1·1; the mixture is then placed in a retort connected with a condensing arrangement, and boiled until nearly one-half of the volume has distilled over. The ebullition is rendered regular by throwing a few scraps of clean platinum foil into the liquid; the residue contains about 20·24 per cent. HCl; 180·8 grammes of such acid, when diluted to a litre with distilled water, furnish a solution approximately normal. As this acid is of constant application a sufficient quantity, 2 or 3 litres, is generally prepared. To determine its exact strength, 50 c.c. of the acid solution are placed into a half-litre flask and diluted to the capacity of the flask; 1 c.c. therefore approximately equals 0·003646 gramme HCl. This solution may be called A; 25 c.c. of A are further diluted to 250 c.c.; 1 c.c. therefore=·0003646 gramme HCl. This may be called B solution. Next, 1·0794 gramme of pure silver is placed in a bottle of 300 c.c. capacity provided with a close stopper, and the metal dissolved in pure dilute nitric acid. The solution is heated on a water bath, and the fumes of the oxides of nitrogen are removed from the bottle from time to time. When the silver is completely dissolved, and the liquid on agitation gives no trace of red fumes, it is allowed to cool. A 100 c.c. pipette, first rinsed with a small quantity of A solution, is filled to the mark with the solution A and emptied into the silver solution. The stopper is then inserted, and the solution briskly shaken for some time until the silver chloride settles out completely and leaves the liquid almost clear. If the hydrochloric acid is of exact strength and strictly normal, and if 1·0794 gramme of pure silver has been accurately weighed, neither silver nor chlorine are in excess in the solution. If one or other body is in excess, to determine which of the two remains in solution, 1 c.c. of deci-normal silver solution is added, and if the liquid remains clear the silver is in all probability in excess; if it becomes turbid the chlorine is present in excess. When this is the case the liquid is again agitated until the solution is once more clear. When the standard solution is properly made, 1 c.c. of solution B contains 0·000365 gramme HCl: this is equal to ·0010794 gramme Ag, and ·0010794×3·5=0·003778 gramme Ag; 101 c.c. of solution A are equivalent to 1·100988−·003778=1·09721 gramme Ag, and accordingly 107·94 : 36·45 : : 1·09721 : x, or x=0·370514. Therefore, as 101 c.c. of solution A contain 0·370514 gramme HCl, the 500 c.c. contain 1·83423 gramme HCl. But as the 500 c.c. are equivalent to 50 c.c. of the original acid, 1 c.c. of the original acid contains ·036684 gramme HCl instead of ·03645 gramme, the quantity required to constitute the normal acid. This difference is usually expressed by a small factor; in this instance $\frac{\cdot036684}{\cdot03645}=1\cdot0064$; 1 c.c. therefore=0·03645×1·0064 gramme HCl; 1 c.c. of the acid is equivalent to 0·10794×1·0064 gramme Ag, or 0·04004×1·0064 gramme NaHO. It is usual to make at least two tests of the strength of the acid before it is used, and the mean result is taken as the correct value.

Preparation of Normal Sulphuric Acid Solution.—In certain processes the standard hydrochloric acid solution cannot be used, and the normal solution of sulphuric acid is employed. This is prepared by diluting about 60 c.c. of pure concentrated sulphuric acid with five or six times its volume of water, and after the mixture is cool, making it up to two litres. The solution will then contain rather more than 49 grammes H_2SO_4 per litre. To determine its exact strength weigh out 2 grammes of recently heated pure sodium carbonate into a weighed platinum basin, and dissolve it in a small quantity of water, covering the solution with a watch glass, and add 25 c.c. of the acid. Place the liquid on a water bath, and when the evolution of gas has ceased remove the cover, rinse its under surface into the dish, and evaporate the liquid to complete dryness. Heat to 180° in the air bath until the weight is constant. The increase in weight of the dish is proportional to the amount of sulphuric acid employed. The amount of sulphuric acid, x, in the 25 c.c. will be the difference between the equivalent of SO_4=96 and CO_3=60, or 36. Therefore 36 is to the equivalent of H_2SO_4, or 98, as the difference between the first and second weighing of the platinum crucible is to the sulphuric acid present in the 25 c.c. Thus, weighing out 1·7210 gramme of pure dry sodium carbonate, added to 25 c.c. of the acid evaporated to complete dryness and heated in the air bath, the difference between the weight of the dish + carbonate, and the dish + mixed carbonate and sulphate, is 0·465 gramme; then 36 : 98 : : 0·465 : x, x=1·266 and $\frac{1\cdot266}{25}=0\cdot05064$. 1 c.c. of the acid therefore contains 0·05064 gramme H_2SO_4.

Preparation of Normal Caustic Soda Solution.—From 42 to 45 grammes of sodium hydrate are dissolved in 800 c.c. of water, and the solution tritrated by normal acid and litmus tincture. The alkaline solution is then diluted until it possesses the normal strength. The caustic soda solution may also be obtained by dissolving about 150 grammes of pure dry sodium carbonate in 3 litres of water, boiling the solution in a clean iron vessel, and adding little by little 80 grammes of freshly burnt lime made into a cream with water; or 250 grammes of bicarbonate may be used instead, heated to a dull redness in a platinum basin, in small portions at a time, for 10 or 15 minutes, to expel the carbon dioxide. The salt is then treated as follows:—The mixture must be boiled until a small quantity of the clear solution no longer effervesces on the addition of an acid in excess. The iron vessel is then closely covered, and after standing twelve or fourteen hours the clear alkaline solution is drawn off by the aid of a syphon.

Preparation of Litmus Solution.—5 or 6 grammes of coarsely powdered litmus are digested with about 200 c.c. of distilled water for a few hours. The clear solution is then decantered off, and very dilute nitric acid added, drop by drop, until the colour is changed to violet. The solution should be neither red nor blue, but between the two tints; when properly neutralized less than $\frac{1}{10}$ c.c. of the standard acid should distinctly redden the solution of 1 c.c., in 100 c.c. of water; on the other hand, the same amount of standard alkali should render the colour blue. The solution should be kept in a wide-mouthed bottle, the cork being cut to allow the air ready access to the interior of the bottle, otherwise the liquid rapidly loses its colour.

Determination of the Strength of the Caustic Soda Solution.—Of the standard sulphuric acid solution 25 c.c. are poured into a porcelain basin, mixed with a measure of litmus solution, and the alkaline liquid is added drop by drop from a burette until the colour is just turned blue. Repeat the determination, taking the mean of the two observations, and dilute the alkaline solution until it corresponds, volume for volume, with the standard acid. Thus, if 25 c.c. of acid require 22 c.c. of soda for neutralizing, 3 c.c. of water should be added for each 22 c.c. of lye, or each litre of alkaline liquid will require the addition of 136 c.c. of water. The dilute liquid should be poured into a large bottle fitted with a wide tube

and syphon; the tube is filled with slaked lime in small pieces, to prevent the entrance of carbon dioxide. A thin layer of paraffin oil poured on the surface of the liquid assists in the preservation of its strength. The exact strength of the diluted liquid is determined by neutralizing varying quantities of standard acid in the manner pointed out, and taking the mean as the true value.

The value of soda-ash, which is a crude sodium carbonate, depends on the amount of available sodium carbonate which it contains. Its impurities, in addition to moisture, mainly consist of sodium hydrate, sulphate, chloride, silicate, and aluminate. It also sometimes contains sodium sulphide, sulphite, and thiosulphate. About 10 grammes of the powdered sample to be analyzed are placed in a weighed platinum crucible, and heated gently for thirty minutes over a spirit lamp; the crucible is then placed in the desiccator, and weighed when cold. The loss of weight gives the amount of moisture contained in the sample. Afterwards place the weighed salt in a beaker, wash out the crucible, and dissolve the salt in a small quantity of water, and filter into a half-litre flask; wash the filter thoroughly, and dilute to the containing mark, shaking the flask; 50 c.c. of the solution, corresponding to one gramme of soda-ash, are taken out and poured into a flask, and 25 c.c. of standard sulphuric acid added; the solution is then boiled until the carbonic acid is expelled. Add a measure of litmus solution and standard soda solution from a burette, drop by drop, until the blue colour of the litmus is restored. For example, let 10·025 grammes of soda-ash be heated and dissolved in water, and the solution made up to 500 c.c. Then let 50 c.c., which correspond to 1·0025 gramme soda-ash, be transferred to a flask, and 25 c.c. of standard sulphuric acid solution (1 c.c. = ·049 gramme $SO_4H_2 \times 1·0204$) added, and the liquid boiled, then mixed with a measure of litmus solution, and standard soda solution added drop by drop until the blue colour is restored; 10 c.c. of soda solution = 9·8 c.c. of standard sulphuric acid; and 9·2 c.c. of the alkaline liquid is required; therefore 10 : 9·2 :: 9·8 : 9·0. Accordingly, $25 - 9·0 = 16·0$ c.c. of standard acid has been used to decompose 1·0025 gramme of soda-ash; and as 1 c.c. of acid contains $0·049 \times 1·0204$ gramme of sulphuric acid, this corresponds to $0·053 \times 1·0204$ of sodium carbonate. The amount of sodium carbonate in the 1·0025 gramme of original soda-ash is therefore $·053 \times 1·0204 \times 16·0 = 0·865$ gramme, or in 100 parts 1·0025 : 100 :: 0·865 = 86·3 per cent.

The value of pearl-ash may be determined in exactly the same manner. As the dried potassium carbonate absorbs moisture very readily, due expedition must be used in weighing this substance. The equivalent of potassium carbonate being 69·1, the factor ·0691 is employed instead of ·053 in the calculation.

Determination of Ammonia.—The quantity of free ammonia in solution may be determined, as in the case of caustic soda or potash, by means of standard acid and litmus solutions. A definite quantity of the solution, say 10 c.c., is placed in a small tared flask and weighed; its absolute weight and specific gravity are thus determined:—If the 10 c.c. weighed 9·0 grammes, their specific gravity would be 0·9000, water being 1. The weighed quantity of the ammonia is then diluted with six or eight times its bulk of water, and titrated directly in the usual manner by the standard acid.

Ammonia in combination may be determined by expelling it by means of caustic soda or lime. The ammoniacal compound (ammonium chloride) is weighed out into a retort, and the ammonia collected in excess of standard acid; the amount of the residual acid is then determined by soda solution. The ammonia contained in many commercial salts, in ammoniacal gas liquor, &c., may be determined by this process. In estimating the ammonia in guano, magnesia must be employed instead of lime or soda, otherwise the nitrogenous organic matter present will be partially decomposed, with evolution of ammonia. The principles involved in the determination of the strength of acid solutions, are the same as those employed with alkaline solutions.

The value of strong acids—hydrochloric, nitric, and sulphuric acids—is frequently deduced from their specific gravities, and tables have been constructed giving the percentage amount of the various acids in solutions of different densities.

TABLE giving the Percentages of real Sulphuric Acid (SO_4H_2) corresponding to various Specific Gravities of Aqueous Sulphuric Acid, at 15° C.

Specific Gravity.	Per Cent.	Specific Gravity.	Per Cent.
1·8426	100	1·398	50
1·842	99	1·3886	49
1·8406	98	1·379	48
1·840	97	1·370	47
1·8384	96	1·361	46
1·8376	95	1·351	45
1·8356	94	1·342	44
1·834	93	1·333	43
1·831	92	1·324	42
1·827	91	1·315	41
1·822	90	1·306	40
1·816	89	1·2976	39
1·809	88	1·289	38
1·802	87	1·281	37
1·794	86	1·272	36
1·786	85	1·264	35
1·777	84	1·256	34
1·767	83	1·2476	33
1·756	82	1·239	32
1·745	81	1·231	31
1·734	80	1·223	30
1·722	79	1·215	29
1·710	78	1·2066	28
1·698	77	1·198	27
1·686	76	1·190	26
1·675	75	1·182	25
1·663	74	1·174	24
1·651	73	1·167	23
1·639	72	1·159	22
1·627	71	1·1516	21
1·615	70	1·144	20
1·604	69	1·136	19
1·592	68	1·129	18
1·580	67	1·121	17
1·568	66	1·1136	16
1·557	65	1·106	15
1·545	64	1·098	14
1·534	63	1·091	13
1·523	62	1·083	12
1·512	61	1·0756	11
1·501	60	1·068	10
1·490	59	1·061	9
1·480	58	1·0536	8
1·469	57	1·0464	7
1·4586	56	1·039	6
1·448	55	1·032	5
1·438	54	1·0256	4
1·428	53	1·019	3
1·418	52	1·013	2
1·408	51	1·0064	1

TABLE showing the Percentage Amount of Caustic Potash (K_2O) in Aqueous Solutions of various Specific Gravities, at 15° C.

Specific Gravity.	Per Cent.	Specific Gravity.	Per Cent.
1·3300	28·290	1·1437	14·145
1·3131	27·158	1·1308	13·013
1·2966	26·027	1·1182	11·882
1·2805	24·895	1·1059	10·750
1·2648	23·764	1·0938	9·619
1·2493	22·632	1·0819	8·487
1·2342	21·500	1·0703	7·355
1·2268	20·935	1·0589	6·224
1·2122	19·803	1·0478	5·002
1·1979	18·671	1·0369	3·961
1·1839	17·540	1·0260	2·829
1·1702	16·408	1·0153	1·697
1·1568	15·277	1·0050	0·5658

Table showing the Percentage Amount of Nitric Acid (HNO_3) contained in Aqueous Solutions of various Specific Gravities.

HNO_3 per Cent.	Spec. Gravity. at 0°C.	Spec. Gravity. at 15°C.	Contraction.	HNO_3 per Cent.	Spec. Gravity. at 0°C.	Spec. Gravity. at 15°C.	Contraction.
100·00	1·559	1·530	0·0000	58·88	1·387	1·368	0·0861
99·84	1·559	1·530	0·0004	58·00	1·382	1·363	0·0864
99·72	1·558	1·530	0·0010	57·00	1·376	1·358	0·0868
99·52	1·557	1·529	0·0014	56·10	1·371	1·353	0·0870
97·89	1·551	1·523	0·0065	55·00	1·365	1·346	0·0874
97·00	1·548	1·520	0·0090	54·00	1·359	1·341	0·0875
96·00	1·544	1·516	0·0120	53·81	1·358	1·339	0·0875
95·27	1·542	1·514	0·0142	53·00	1·353	1·335	0·0875
94·00	1·537	1·509	0·0182	52·33	1·349	1·331	0·0875
93·01	1·533	1·506	0·0208	50·99	1·341	1·323	0·0872
92·00	1·529	1·503	0·0242	49·97	1·334	1·317	0·0867
91·00	1·526	1·499	0·0272	49·00	1·328	1·312	0·0862
90·00	1·522	1·495	0·0301	48·00	1·321	1·304	0·0856
89·56	1·521	1·494	0·0315	47·18	1·315	1·298	0·0850
88·00	1·514	1·488	0·0354	46·64	1·312	1·295	0·0848
87·45	1·513	1·486	0·0369	45·00	1·300	1·284	0·0835
86·17	1·507	1·482	0·0404	43·53	1·291	1·274	0·0820
85·00	1·503	1·478	0·0433	42·00	1·280	1·264	0·0808
84·00	1·499	1·474	0·0459	41·00	1·274	1·257	0·0796
83·00	1·495	1·470	0·0485	40·00	1·267	1·251	0·0786
82·00	1·492	1·467	0·0508	39·00	1·260	1·244	0·0775
80·96	1·488	1·463	0·0531	37·95	1·253	1·237	0·0762
80·00	1·484	1·460	0·0556	36·00	1·240	1·225	0·0740
79·00	1·481	1·456	0·0580	35·00	1·234	1·218	0·0729
77·66	1·476	1·451	0·0610	33·86	1·226	1·211	0·0718
76·00	1·469	1·445	0·0643	32·00	1·214	1·198	0·0692
75·00	1·465	1·442	0·0666	31·00	1·207	1·192	0·0678
74·01	1·462	1·438	0·0688	30·00	1·200	1·185	0·0664
73·00	1·457	1·435	0·0708	29·00	1·194	1·179	0·0650
72·39	1·455	1·432	0·0722	28·00	1·187	1·172	0·0635
71·24	1·450	1·429	0·0740	27·00	1·180	1·166	0·0616
69·96	1·444	1·423	0·0760	25·71	1·171	1·157	0·0593
69·20	1·441	1·419	0·0771	23·00	1·153	1·138	0·0520
68·00	1·435	1·414	0·0784	20·00	1·132	1·120	0·0483
67·00	1·430	1·410	0·0796	17·47	1·115	1·105	0·0422
66·00	1·425	1·405	0·0806	15·00	1·099	1·089	0·0336
65·07	1·420	1·400	0·0818	13·00	1·085	1·077	0·0316
64·00	1·415	1·395	0·0830	11·41	1·075	1·067	0·0296
63·59	1·413	1·393	0·0833	7·22	1·050	1·045	0·0206
62·00	1·404	1·386	0·0846	4·00	1·026	1·022	0·0112
61·21	1·400	1·381	0·0850	2·00	1·013	1·010	0·0055
60·00	1·393	1·374	0·0854	0·00	1·000	0·999	0·0000
59·59	1·391	1·372	0·0855				

Table showing the Percentage Amount of Ammonia in Aqueous Solutions of the Gas of various Specific Gravities, 14° C.

Specific Gravity.	NH per Cent.	Specific Gravity.	NH per Cent.
0·8844	36	0·9314	18
0·8864	35	0·9347	17
0·8885	34	0·9380	16
0·8907	33	0·9414	15
0·8929	32	0·9449	14
0·8953	31	0·9484	13
0·8976	30	0·9520	12
0·9001	29	0·9556	11
0·9026	28	0·9593	10
0·9052	27	0·9631	9
0·9078	26	0·9670	8
0·9106	25	0·9709	7
0·9133	24	0·9749	6
0·9162	23	0·9790	5
0·9191	22	0·9031	4
0·9221	21	0·9873	3
0·9251	20	0·9915	2
0·9283	19	0·9959	1

Table giving the Percentage Amount of Hydrochloric Acid contained in Aqueous Solutions of the Gas of various Specific Gravities, at 15° C.

Specific Gravity.	HCl Per Cent.	Specific Gravity.	HCl Per Cent.
1·200	40·777	1·1000	20·388
1·1982	40·369	1·0980	19·980
1·1964	39·961	1·0960	19·572
1·1946	39·554	1·0939	19·165
1·1928	39·146	1·0919	18·757
1·1910	38·738	1·0899	18·349
1·1893	38·330	1·0879	17·941
1·1875	37·923	1·0859	17·534
1·1857	37·516	1·0838	17·126
1·1846	37·108	1·0818	16·718
1·1822	36·700	1·0798	16·310
1·1802	36·292	1·0778	15·902
1·1782	35·884	1·0758	15·494
1·1762	35·476	1·0738	15·087
1·1741	35·068	1·0718	14·679
1·1721	34·660	1·0697	14·271
1·1701	34·252	1·0677	13·863
1·1681	33·845	1·0657	13·456
1·1661	33·437	1·0637	13·049
1·1641	33·029	1·0617	12·641
1·1620	32·621	1·0597	12·233
1·1599	32·213	1·0577	11·825
1·1578	31·805	1·0557	11·418
1·1557	31·398	1·0537	11·010
1·1536	30·990	1·0517	10·602
1·1515	30·582	1·0497	10·194
1·1494	30·174	1·0477	9·786
1·1473	29·767	1·0457	9·379
1·1452	29·359	1·0437	8·971
1·1431	28·951	1·0417	8·563
1·1410	28·544	1·0397	8·155
1·1389	28·136	1·0377	7·747
1·1369	27·728	1·0357	7·340
1·1349	27·321	1·0337	6·932
1·1328	26·913	1·0318	6·524
1·1308	26·505	1·0298	6·116
1·1287	26·098	1·0279	5·709
1·1267	25·690	1·0259	5·301
1·1247	25·282	1·0239	4·893
1·1226	24·874	1·0220	4·486
1·1206	24·466	1·0200	4·078
1·1185	24·058	1·0180	3·670
1·1164	23·650	1·0160	3·262
1·1143	23·242	1·0140	2·854
1.1123	22·834	1·0120	2·447
1·1102	22·426	1·0100	2·039
1·1082	22·019	1·0080	1·631
1·1061	21·611	1·0060	1·124
1·1041	21·203	1·0040	0·816
1·1020	20·796	1·0020	0·408

Table showing Percentage Amount of Soda (Na_2O) in Aqueous Solutions of various Specific Gravities.

Specific Gravity.	Per Cent.	Specific Gravity.	Per Cent.
1·4285	30·220	1·3198	22·363
1·4193	29·616	1·3143	21·894
1·4101	29·011	1·3125	21·758
1·4011	28·407	1·3053	21·154
1·3923	27·802	1·2982	20·550
1·3836	27·200	1·2912	19·945
1·3751	26·594	1·2843	19·341
1·3668	25·989	1·2775	18·730
1·3586	25·385	1·2708	18·132
1·3505	24·780	1·2642	17·528
1·3426	24·176	1·2578	16·923
1·3349	23·572	1·2515	16·379
1·3273	22·967	1·2453	15·714

Specific Gravity.	Per Cent.	Specific Gravity.	Per Cent.
1·2392	15·110	1·1042	7·253
1·2280	14·500	1·0948	6·648
1·2178	13·901	1·0855	6·044
1·2058	13·297	1·0764	5·440
1·1948	12·692	1·0675	4·835
1·1841	12·088	1·0587	4·231
1·1734	11·484	1·0500	3·626
1·1630	10·879	1·0414	3·022
1·1528	10·275	1·0330	2·418
1·1428	9·670	1·0246	1·813
1·1330	9·066	1·0163	1·209
1·1233	8·462	1·0081	0·604
1·1137	7·857	1·0040	0·302

Sometimes it is necessary to correct the indications of the hydrometer, or specific gravity bottle, by titrating the acid solution. The determination of the strength of nitric, hydrochloric, and sulphuric acids by caustic soda and litmus solutions is simple, and from the foregoing examples will be understood.

Determination of the Strength of Acetic Acid, Pyroligneous Acid, and Vinegar.—As sodium acetate possesses a feeble alkaline reaction, which interferes with the correct determination of the final point, the estimation of the strength of this acid in its various forms cannot be made with accuracy by direct titration with caustic soda solution. The method generally adopted consists in adding to a known quantity of the acid a weighed quantity in excess of finely powdered marble, heating the liquid to boiling, filtering, washing the residual calcium carbonate with hot water, dissolving it in a slight excess of normal hydrochloric acid, and titrating with caustic soda and litmus solution. This method is of great value in testing brown pyroligneous acid or highly coloured vinegars.

Determination of Combined Carbon Dioxide.—The amount of carbon dioxide in soluble carbonates may be determined by decomposing them with a solution of calcium chloride, throwing the precipitated calcium carbonate on to a filter, washing thoroughly with hot water, dissolving in an excess of standard hydrochloric acid, and determining the excess of acid by standard soda solution in the usual manner. The acid carbonates (bicarbonates) need the addition of ammonia with the calcium chloride. The carbon dioxide in insoluble carbonates, as in calamine, ferrous carbonate, white lead, mortar, cements, &c., is determined by expelling the gas by the action of hydrochloric acid, absorbing it by ammonia, and precipitating by the addition of calcium chloride. The calcium carbonate is then treated in the manner above stated.

Estimation of Carbonic Acid (Carbon Dioxide).—The amount of carbonic acid in spring, river, or mineral water may be accurately estimated in the following manner:—100 c.c. of the water to be examined are placed in a dry flask, together with 3 c.c. of a strong neutral solution of calcium chloride, and 2 c.c. of a saturated solution of ammonium chloride; 50 c.c. of lime-water, the strength of which is accurately known, are then added, when the flask is closed by an india-rubber stopper, and the contents, 155 c.c., shaken. In about twelve hours the whole of the calcium carbonate will have separated out, and the liquid become clear; 50 c.c. of the clear liquid are then measured off, and the residual amount of lime ascertained by deci-normal hydrochloric acid. A solution of oxalic acid may be at times substituted for the hydrochloric acid; it should be made of such a strength that 1 c.c. is equivalent to 1 milligramme of carbon dioxide. This solution may be obtained by dissolving 2·8636 grammes of pure dry crystallized oxalic acid in water, and diluting to 1 litre. The lime-water should be of such strength that 25 c.c. are equal to 23 or 24 c.c. of acid. The final point of the reaction may be determined by the aid of a drop of tincture of pure rosolic acid, which gives a bright red colour in presence of the alkaline earth, that disappears on neutralizing with an acid. Turmeric paper may be used instead of rosolic acid. Swedish paper cut in strips is immersed in tincture of turmeric, and dried. A drop of the liquid on the paper gives a reddish-brown stain so long as the least trace of the alkaline earth remains in the free state.

The following example illustrates the process:—100 c.c. of the water of the Irish Channel are mixed with 3 c.c. of calcium choride, and 2 c.c. of ammonium chloride, together with 50 c.c. of lime-water. 50 c.c. of lime-water = 46·4 c.c. of oxalic acid, of which 1 c.c. = 1 milligramme CO_2. After standing fifteen hours, 50 c.c. of the solution required 13·3 c.c. of standard acid for neutralization, consequently $46{\cdot}4 - (13{\cdot}3 \times 3{\cdot}1) = 5{\cdot}2$. 100 c.c. of the sea-water therefore contain 5·2 milligrammes carbon dioxide.

MUSIC.—CHAPTER XIII.

HARMONY—COUNTERPOINT AND ITS LAWS, WITH ILLUSTRATIONS—CANON—FUGUE—INSTRUMENTS AND INSTRUMENTATION—MUSICAL STUDY.

In Chapter VII. (pp. 749–753) a brief account was given of the various Church or Gregorian modes, how they originated, and the effect they had had upon much of the music of the present day. With the limited space at our disposal it is impossible to give in a similar way, or to a like extent, any idea, at once correct and adequate, of the rise and progress of harmony. Having its origin in rude and unlettered times, its growth has been gradual and widespread—the work of many minds in many generations. Authorities agree in supposing it to have originated in the natural love of the human ear for the harmonious mingling of voices and instruments, and in the ability possessed by many individuals to give, spontaneously, a second or accompanying part to any familiar melody. This gift seems to have been called into active exercise in the church in the course of the ninth century. The principal melody was then termed the "plain song" or *Canto Fermo*, and the improvised part was the *Descantus*, descant or "double song." As time advanced, and "plain songs," with their accompanying descants, were improved and increased in number, the practice of improvising or descanting rose almost to the dignity of a science. Soon rules for the proper construction of descants came into vogue, and "added parts" began to make their appearance on paper either in a written or printed form. When the art of harmonization (which this descanting really was) had reached this stage the name of "counterpoint" was given to it. This arose from the circumstance that the musical notes being diamond-shaped their points stood one against the other, thus  or point counter point.

As now practised, counterpoint is divided into two distinct classes—viz. single (or simple) and double counterpoint. Counterpoint is single when it is not intended to be inverted, and double when either of the given parts may serve as a bass to the other. Each of these classes is again subdivided into five distinct orders or species.

The *first* consists in the addition of a part or parts with notes equal in duration to those of the Canto Fermo or subject. This is the simplest of all. The rules which chiefly distinguish it from ordinary harmony are—

(1) No discords can be used, and, with three or four parts, no second inversions (C positions).

(2) The same note should not be repeated without one or more intervening.

(3) In counterpoint of only two parts, a fifth must not follow a third when both parts move by step.

(4) In moving by skips, a melody should not embrace any dissonant interval, as—

Key C. {|d^1 :— |r :— || or *Key G.* {|s$_1$:— |f :— ||

without at least two notes coming between the discord, thus:—

{|d^1 :l |f :r || or {|s$_1$:t$_1$ |r :f ||

(5) A melody must not include any augmented interval, as—

{|f :— |t :— || or {|d :— |se :— ||

and if, in the inversion of either of these, a diminished interval is employed, the melody must return within the interval, as—

{|f :— |t_1 :— |d :— ||d^1 :— |se :— |l :—||

(6) The perfect or semiperfect tonic cadence must never be employed except at the end of the exercise or piece.

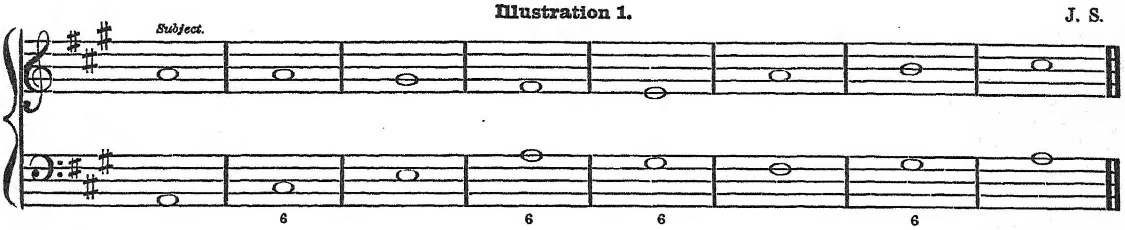
(7) At the close, the leading note must rise to the tonic; elsewhere it is free to rise or fall.

(8) In two-part counterpoint, not more than three-thirds or three-sixths can be used in succession.

(9) A perfect interval (fifth or octave) must always be used in the opening, but in the working out thirds and sixths are to be preferred.

According to these rules, the first section of the tune "Old Hundred," taken as a Canto Fermo, might, for first order and in two parts, be treated thus:—

Illustration 1. J. S.



The *second* consists of a part or parts with two, or, in triple time, three notes against one of the subject. In this species the first note in each measure must be concordant; the other or others may either be notes belonging to the same chord, or dissonant, usually called "passing notes," moving by step to and from a concord. Only one chord must be used in each measure. The same Canto Fermo so treated would appear somewhat as follows:—

Illustration 2. J. S.

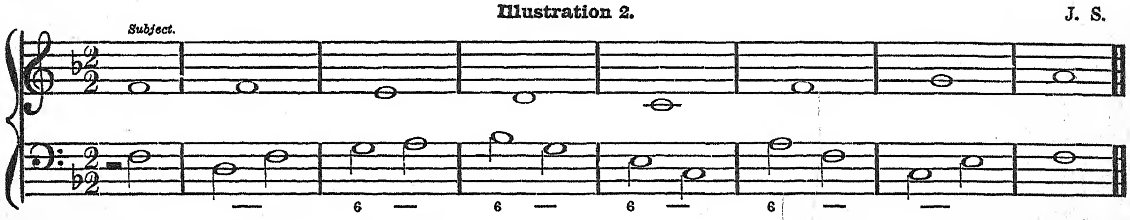


Illustration 3.—Another Arrangement. J. S.

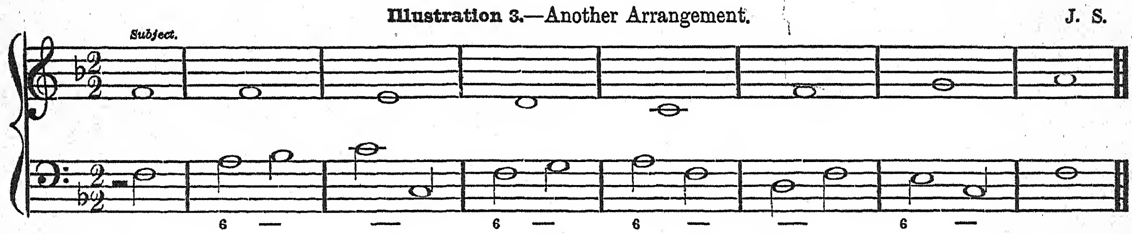
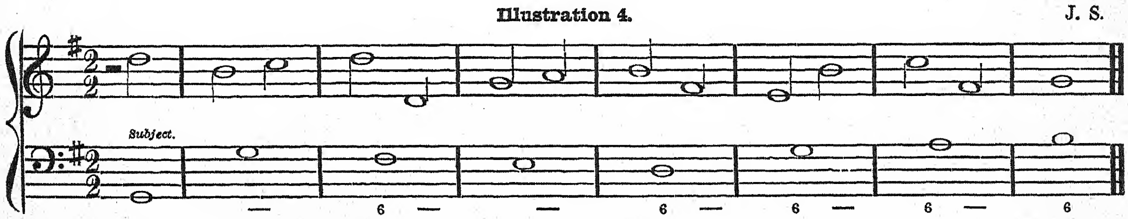


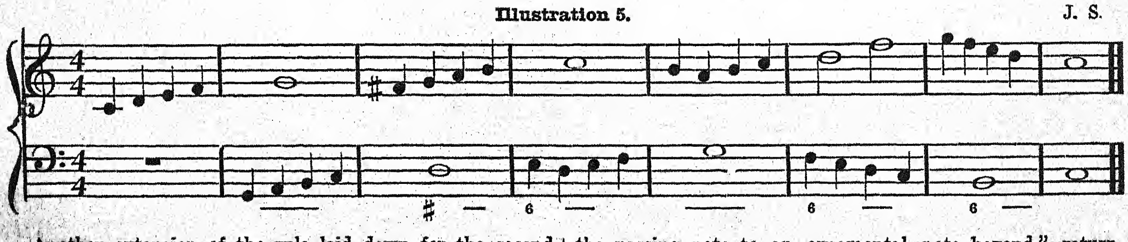
Illustration 4. J. S.



The *third* has four, six, or eight notes (Sir G. A. Macfarren says any number greater than two) against one of the subject. As in the second species, the first note of every measure must be consonant; the others may either belong to the same chord or be passing notes—the latter are to be preferred.

The rule that concord must succeed discord is here somewhat relaxed or extended. Discord may follow discord if the part which has the discord keeps moving by step, and the rule regarding the concordant note on the first of each measure is observed, thus:—

Illustration 5. J. S.



Another extension of the rule laid down for the second species is what Sir G. A. Macfarren calls "the graceful, elastic, and most convenient melodic device of leaping from the passing note to an ornamental note beyond," returning afterwards to the proper resolution, in the following manner:—

Illustration 6. J. S.

The Canto Fermo formerly employed would now bear some such counterpoint as the following:—

Illustration 7. J. S.

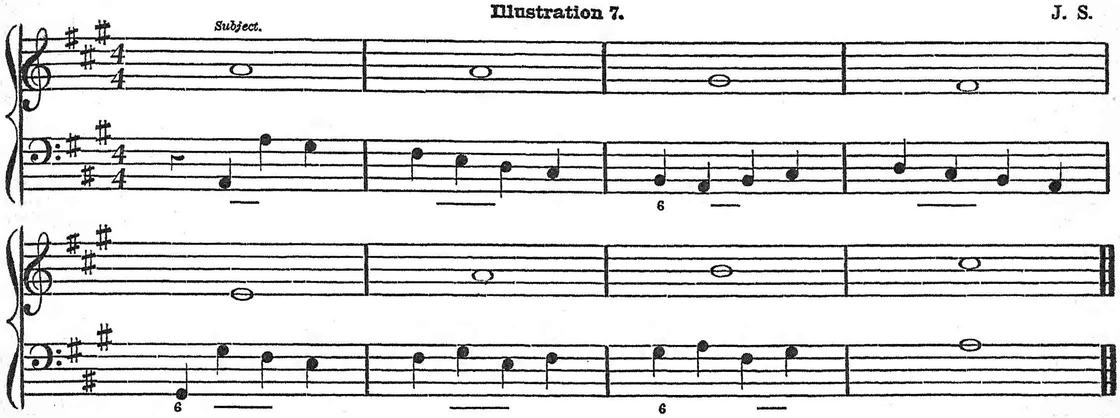
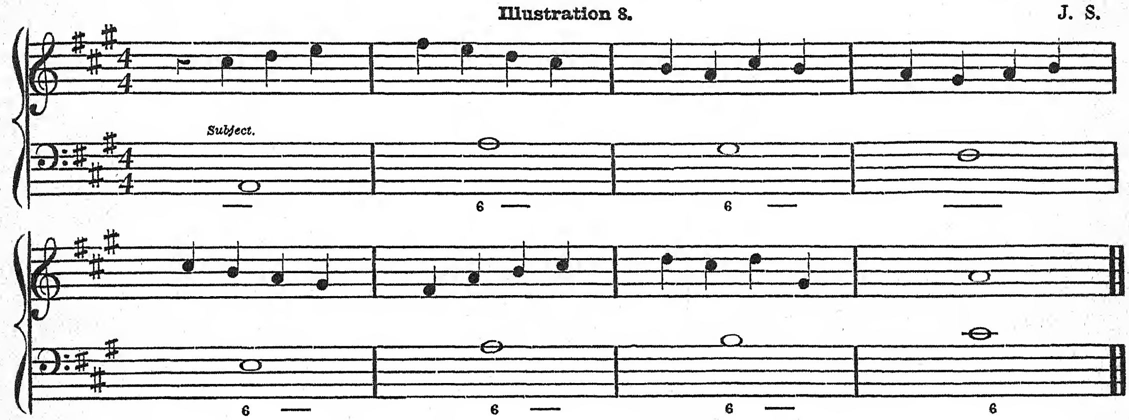


Illustration 8. J. S.



The *fourth* has syncopation [*i.e.* interruption of accent] in the melody, and suspended discords in the harmony. Here, as in the first species, the notes are equal in length to those in the Canto Fermo, but they begin on the second half of the measure, so that one part moves on, as it were, a step behind the other. Exercise 112 (page 1040) may serve as an illustration of this order, in which, as will be seen, the note which has the accent is discordant, and the unaccented note is concordant.

The *fifth*, called *florid counterpoint*, is said to be a combination of all the orders, but will be best understood as an extension and ornamentation of the third and fourth, particularly the latter. Exercise 112 might be ornamented from the fourth into the fifth species thus:—

Illustration 9. J. S.

Double counterpoint, as already stated, consists of two or more melodies that are capable of inversion (page 853). The above illustration of the fifth species is really written in double counterpoint—*i.e.* the upper part would make a correct bass to the under.

Canon is a musical device or form founded on the laws of counterpoint, in which, after a certain number of pulses or measures, a given melody in one part is correctly imitated by another or others throughout at a certain interval above or below. In that which follows, the upper part is imitated by the under after one measure at the interval of a fourth.

CANON (Infinate).

Key E♭. Allegretto. *Two in one, in the Fourth below.* J. S.

:S:
m :— |— :d ||r :— |s :— |— :f.m|f :r |m :— |l :— |— :s.f|s :m |f :—
Praise the Lord, praise - - - - the Lord, praise - - - the Lord;
: | : |t_1 :— |— :s_1 |l_1 :— |r :— |— :d.t_1|d :l_1 |t_1 :— |m :— |— :r.d
Praise the Lord, praise - - - the Lord, praise - -

— :s.f|m :f.s|l :— |— :— |s :— |fe :s.l|t :— |— :— |l :— |s :l.t|d' :—
Your voi - ces raise, your voi - ces raise, your voi - ces raise -
r :t_1 |d :— |— :r.d|t_1 :d.r|m :— |— :— |r :— |d :r.m|f :— |— :— |m :—
- the Lord; Your voi - ces raise, your voi - ces raise, your

— :— |t :s |l :t.d'|r'.d':t.l|s :l.t|d' :d' |t :d'.r'|m'.r':d'.t|l :t.d'|r' :— |— :d'.t
- - - in songs - - of praise, - in songs - of praise; for ev - - er
r :m.f|s :— |— :— |f :r |m :f.s|l.s:f.m|r :m.f|s :s |fe :s.l|t.l:s.f|m :f.s
voi - ces raise - - - - in songs - - of praise, - - in songs - - of praise; for

D.S.
d' :f |ta :— |— :ta |ta :l.s|l :r |s :— |— :s |s :f.m|f :— |m :— |— :d
be His name a - dor'd, - - His name a - dor'd. - - Praise the
l :— |— :s.fe|s :d |f :— |— :f |f :m.r|m :l_1 |r :— |— :r |r :d.t_1|d :—
ev - er be His name a - dor'd, - His name a - dor'd. - -

Coda.
r :— |s :— |— :f.m|f :r |m :— |l :— |— :s.f|s :m |f :— |— :s
Lord, praise - - the Lord, praise - - the Lord, and
t_1 :— |— :s_1 |l_1 :— |r :— |— :d.t_1|d :l_1 |t_1 :— |m :— |— :r.d|r :t_1
Praise the Lord, praise - - the Lord, praise - - the

Rall.
l :t |d' :— |— :r'.d'|t :d' |d' :— |t :— |d' :— |— :— |— : | :
let His name for ev - er be a - dor'd. - - - -
d :r |m :d |f :r |s :m |l :f |s :s_1 |d :— |— :— |— : | :
Lord, and let His name, His name for ev - er be a - dor'd. - - - -

Artificial as this form may seem, it has been much used by every great composer, both ancient and modern.

What is known as the *Fugue* form would seem to have resulted from an extended use of the canon. In this, a subject or motive of two, four, or six measures given out by one part is answered by another in the dominant key a fifth above or a fourth below, this answer being accompanied by what is called the *countersubject*, which, being intended for after-use, is generally written in double counterpoint with the principal theme.

In the following illustration (1) the soprano gives out the subject, which is not quite finished before (2) the alto enters with the answer a fourth below, which answer is, in turn, accompanied by the countersubject in the soprano.

Illustration 10. J. S.

In the above the parts are capable of inversion—*i.e.* a tenor voice might have the subject and countersubject a fifth below the alto.

The other musical forms which have been or are in general use may be classified as consisting of (1) the ancient twofold form which, as its name implies, contains two distinct musical ideas, the second of which can in some manner be looked upon as a reply to the first. Many of our psalm and hymn tunes are really illustrations of this principle. The ordinary song and part-song are frequently developments of the same idea, but to these a *coda* or finishing part is often added. See the song "The Mitherless Bairn," p. 660, in which the second section imitates or replies to the first, the third section contains what may be looked upon as the second melody, the fourth again reminds of the first, and the fifth and sixth sections are a summing-up of, or coda to, the whole piece. (2) The modern twofold form, which was invented, or at least greatly improved and brought into general use, by Haydn, and so has come frequently to be called by his name.

The Haydn or *Sonata* form consists of—(1) a melody in

first or principal key; and (2) a melody or second theme in some nearly related key, generally the dominant. These, with melodic guides, modulating and ornamental passages, form the first division of the movement. The second division consists of (*a*) passages in which some part or parts of the first division are developed by means of modulations, transitions, and harmonic and melodic imitations. Canon and other contrapuntal devices may also be introduced at this division. These passages should lead up to (*b*) a repetition of the first melodies, both of which must now appear in the original key, but may be (1) curtailed, (2) lengthened, or (3) ornamented according to the taste or talent of the composer. This form is often most successfully employed in vocal music; but it has received its most splendid illustrations in music for instruments, especially the pianoforte.

(3) The threefold form, which generally consists of (*a*) a melody in principal key, (*b*) an answering melody in a key nearly related thereto, and (*c*) a recapitulation of the original melody, which towards the close is not unfrequently somewhat varied. Handel's well-known air, "See the Conquering Hero Comes," may serve as a model of this form. The melody to Hogg's "Skylark," p. 661, is also a good illustration of this much-used and most effective means for the expression of musical ideas.

There are other musical forms, chiefly, however, devoted to instrumental music, such as the March, the Minuet, the Rondo, the Variation, &c., nearly all of which can be traced as being more or less related to those just explained. The student who would thoroughly master the subject cannot do better than consult the little book written upon it by Sir F. A. Gore Ouseley; "Musical Theory," Book V., by John Curwen; and "The Elements of the Beautiful in Music," by E. Pauer, published by Novello.

Although the rules and maxims relating to musical doctrine or theory laid down in our previous chapters are in general applicable both to voices and instruments, this course of lessons, as such, must be considered as having relation almost entirely to vocal music. The modern orchestra and modern instrumentation would require more space for full and proper treatment than is compatible with the popular aims of the "Home Teacher." They are besides very difficult branches of musical study, and require, on the part of the successful student, a great deal of preliminary knowledge, both theoretical and practical, much leisure time, close and long-continued application, and in most cases the personal instruction and criticism of a professional teacher. A slight sketch may perhaps suffice for the information, guidance, and help of those who have followed us thus far and may desire to proceed further than our present purpose and opportunity permit us to go.

Instruments may be divided into four great orders, viz.:—(1) string instruments, (2) instruments made of wood played by means of a hole or mouth-piece—"wood-winds," as they are frequently termed, (3) wind instruments constructed of brass, and (4) instruments of percussion. Each of these may again be subdivided into various subclasses—*e.g.* (*a*) stringed instruments played with a bow, like the violin and its near relations, the viola, the violoncello, and the double bass; (*b*) those played by means of plucking the strings with the hand, as the harp, the guitar, the mandoline; and (*c*) the pianoforte, which is a stringed instrument played through the medium of keys. Among the wood-winds also there are (*a*) those having reeds attached to the mouthpiece, chief of which are the oboe (or hautboy), the clarionet family, and the bassoon; (*b*) those played without reeds, as the flute and piccolo flute; and (*c*) wind instruments with key-boards, like the organ, its American namesake, and the harmonium. The brass wind instruments are a family literally too numerous to mention, but the horn, the trumpet, the cornet, and the various trombones are the most important. Drums, bells, cymbals, and triangles are the chief instruments of percussion.

For military and processional purposes brass and other wind instruments must ever be held in highest estimation, but in an orchestra the "strings" form the most essential constituent. Here the violins usually sustain two parts of the harmony, and are called respectively *first* and *second*, standing in relation to each other as alto to soprano. The third or tenor part in the harmonic combination is supplied by the viola, which in reality is only a larger sized violin tuned a fifth lower. The bass part is in general taken by the violoncello, which is doubled an octave below by the double bass. Many and beautiful are the effects which composers have obtained from these instruments alone. Upon the violin scale passages of all kinds, whether diatonic or chromatic, and every variety of phrasing, are practicable. As a means of musical expression and feeling this instrument is unsurpassed—indeed matchless.

The orchestral instruments next in importance, or at least those earliest and most frequently employed, are the oboe, the bassoon, and the horn. As already stated, the first two are wood-winds played by means of what is called a "double reed." There is an individuality about the tone of these instruments which causes them when once heard to be for ever remembered. The oboe, says Mr. E. Prout in his "Primer on Instrumentation" (Novello & Co.), "is equally useful for the expression either of melancholy, tenderness, or gaiety," while the bassoon excels alike in the pathetic and grotesque. There are two kinds of horns employed in the orchestra: (1) the natural or hand horn, so called because some of its tones are affected by the insertion of the hand into the bell or outlet of the instrument; and (2) the valve or *ventil* horn. With each of these instruments the different tones are produced almost entirely by the varied degrees of lip and wind pressure supplied by the performer, but in the case of the ventil horn valves or pistons, which are worked by the fingers, shorten or lengthen the tube, and so raise or deepen the pitch of the sounds produced. When well played there is great nobility of expression in the horn, sustained notes and melodies being most effective.

If to these instruments are added the flute and the clarionet, the characteristics of which are well known, what has been called the small orchestra will be complete. The musical resources thus furnished have been beautifully illustrated by Haydn, Mozart, and contemporary composers. Although in more modern times these have been supplemented by the other instruments indicated above, it is sometimes doubtful whether the increase of sound thereby obtained should be considered an unmixed advantage.

The pianoforte may be viewed in two aspects: as (1) an orchestral instrument, in which relation it was perhaps first employed by Beethoven; and (2) as being in itself a small or "drawing-room orchestra." In the latter capacity it has found universal acceptance, and pianists of ability are now very numerous. It is to be feared, however, that superficiality of attainment in regard to this instrument is the rule, not the exception. Upon all who would acquire proficiency in the use of this or of any instrument, it is necessary to urge thoroughness. That in all musical work is indispensable to success.

Music is not merely an art or an ornamental accomplishment: it is a science founded on rules and principles gathered together by the experience and thought of great and gifted minds, and communicated to us by them with the generous design that we should acquire easily what they by difficulty and toil attained. Science will not suffer anyone to be superficial, under pain of being ineffective. Practice makes perfect only when pursued on right principles. Attain these, understand and apply them, give conscientious toil to the accomplishment of what they teach, and art will be and give an inexpressible delight to those who pursue it. In singing never trust wholly to the ear, but guide it by the scientific laws of harmony, and control expression by the principles of music; and in instrumentation do not be content with showy dexterity and apparent power of execution, caught up by imitation and worked into a habit. Every true student is earnest. He seeks, and in his happiest mood is only satisfied when he has gained, the accurate sense of thoroughly adjusted perfection. Something lower may gain currency and pass among the many as exquisite, but he feels the attained only a step to something "higher yet" attainable. Music is the beauty of sound made real. It brings brightness with it, and illumines life. It is the purest of human pleasures, and it is the most fascinating of all the Divine gifts. Let us then be thorough in our use of it.

DRAWING.—CHAPTER XII.

THE ATTRACTIONS OF ART—THE BENEFITS DERIVED FROM IT, AND THE JOY IT YIELDS.

It is no easy matter to learn to draw skilfully. Help, guidance, suggestion, and instruction may be obtained from able books and willing teachers; but even if the student takes the fullest advantage of all these, he will find that in this, as in all other studies, the necessity for hard work still remains. Even with high talent—or that "ineffable something" which we call genius—success is not possible without industry. Mr. Ruskin says—"During such investigation as I have been able to give to the lives of the artists whose works are in all points noblest, no fact ever looms so large upon me—no law remains so steadfast in the universality of its application—as the fact and law that they are all great workers; nothing concerning them is matter of more astonishment than the quantity they have accomplished in the given length of their life; and when I hear a young man spoken of as giving promise of high genius, the first question I ask about him is always—Does he work?" A saying of William Blake's on art is in the same spirit. A student having once come to him craving advice—"Do you," asked Blake, "work in fear and trembling?" "Indeed I do, Sir!" was the reply. "Then," said the poet-painter quietly, "you'll do!"

Fortunately in art-study this necessary work is neither painful nor unattractive. The young artist will find that there is pleasure to be obtained, not only in the work done, but in the doing of it. It is true that some artists have led lives full of trouble, and even ended their days in sadness; but this has been greatly due to circumstances apart from their life-work; indeed they have in most cases taken refuge from the storm and stress of fortune or fate in their much-loved work, and have found in it almost their only pleasure. However, it is pleasant to know that even such instances are few. In the majority of cases artists lead happy lives, and perhaps, on the whole, the happiest part of it is when they were students living on "porridge and tea," and doing long hours of labour. A bright picture of such a life is to be found in the autobiography of B. R. Haydon—a book which is not only as fascinating as a romance, but also very instructive in many ways to the art-student.

Haydon went up to London in 1804, and met there Hilton and Jackson; they were soon joined by "a raw, tall, pale, queer Scotchman"—David Wilkie. These men, in a sort of "quadruple alliance," became close friends, lived hard but happy lives—studying in the Academy schools, dining in obscure chop-houses, meeting together for tea in each other's little room, when they sat on the side of the bed for lack of chairs, talking over their plans of study, drawing together in the evening after the schools were closed, clubbing their scanty guineas to pay another young Scotchman of extra intellectual calibre, Charles Bell (afterwards Sir Charles Bell, author of the "Anatomy of Expression," &c.), to lecture to them on the human subject, and, after a while, painting pictures which the world will neither soon nor willingly forget.

"Happy period!" says Haydon, "painting and living in one room, as independent as the wind—no servants—no responsibility—reputation in the bud—hopes endless—ambition beginning—friends untried, believed to be as ardent and as sincere as ourselves—looking on the empty chairs, after breaking up, as if the strings of one's affections were torn out, and such meetings would be no more."

Students of to-day should bear in mind that they have many advantages and encouragements which these men did not enjoy. It is no longer necessary to leave home and friends and go to London for instruction. Art schools exist all over the provinces, the instruction given in them is gradually improving, and in some cases has already reached a very high standard. Even if necessity or ambition should drive or lead the student to London, schools are open to him there without payment of fee, while scholarships and prizes which will enable him to live in fairly comfortable circumstances while pursuing his studies, are offered.

In all these and many other ways, and increasingly, the art student is being encouraged in his work; the burden which others have had to bear is made lighter for him; his life is, or at least may be, comparatively easy; and it behoves him to remember that, possessing all these advantages, higher attainments and greater results are naturally and rightly expected from him.

But the study of art is not confined only to the few who hope, aspire, or intend to become artists. A love of art is widely, almost universally, diffused, and art-study is recognized as a necessary part of our educational system. The benefits to be derived from, and conferred by, this branch of education are great and numerous. The increase of art-knowledge brings with it an increased knowledge of the natural world, and of man's work therein. A love of nature and her works may undoubtedly exist in those who have no knowledge of art, but it is certainly true that the love of, and delight in, the glorious beauty of the world is excited, fostered, and even produced by an artistic education. The study of drawing and painting, nay, even the study of mechanical drawing by the aid of instruments, leads the student to increased accuracy of observation, and enables him to form as well as to give a better description of all he sees.

The quality of a description, whether given by pen or pencil, is due in great measure to the amount of minute and accurate detail in it; and this detail is far more likely to be seen—and is only able to be reproduced so as to be seen—by those who have received an artistic education than by those who have not. How often, too, do we find that art enables that to pass through the eye and touch the heart which the ear, informed as it must be by fleeting words, cannot discern? The teaching of drawing—the practical training of the eye and the hand—as part of the national system of education is calculated not merely to make the young more skilful and useful, but also to elevate and improve the mind of the people, creating happiness by increasing the joys of sight, tending to orderliness and accuracy in all hand-work, providing interesting and beneficial occupation for lives which might otherwise be wasted and unimproved, and finding for the leisure hours of those who have to do their daily task of breadwinning sources of delight alike by fireside or in field, which the uninstructed in art and heart can never know. Everybody welcomes the pleasures which enter the mind by eye-gate, and "the art of picturing" is one which invariably interests and attracts. Art-study, besides its happy influence in charming the sense of sight, refines the taste and quickens the higher powers of the spirit. It not only benefits industry and brightens commerce, but it adds to the pleasures of memory the delight of visual reproduction, and supplies to the persevering and resolved student one of the readiest and best opportunities of proving that "we conquer difficulties by daring to attempt them."

It is a wise forethought which has determined to open up opportunities for this culture of art and taste to the children of this empire. It is right that every faculty should be developed, and that, to even the poorest, as far as opportunity and ability can secure it, the power of drawing should be imparted. So may the pathways of prosperity be made smooth and plain to many who could not otherwise have overcome the obstacles to the progress of the poor though talented, and in this way the world at large may benefit from the works of genius produced by those to whom the national provision for the culture of art has given impulse and encouragement.

The study of drawing trains those who are engaged in it to keenness, correctness, and definiteness of observation, and provides a peculiarly pleasant discipline in the habit of making the best possible use of our eyes in regard to position, outline, distance, relation of parts, and appearances generally. By thus requiring the reproduction of things seen (or even imagined) with all the characteristics of individual objects not only singly but in composition, it enables us to test the precision and power of our observation. The familiarity of the exercise of the sense of sight tends to withdraw it from the operation of the will; but the acquisition of the art of drawing brings the exercise of vision directly under the control of the will, and gradually produces that precious seeing in the eye which is known as artistic observation. Drawing helps us to vivify, strengthen, and rectify the observative

faculty, by requiring (1) perceptive accuracy—a result of close, repeated, and intense exertion of the power of vision and the self-excited energy of attention; and (2) appropriation—the taking into the mind, and making an abiding possession therein, of what we see. The bringing of the will's agency and energy into operation counteracts the tendency to be content with merely vague and transient impressions of things, persons, and scenes, and cultures in us the power of that second nature to which the name of habit is given. Those who acquire *that* will not grudge to give hearty labour to keep the capacity in exercise, and make of drawing one of the refining influences of domestic life.

It is highly commendable, as we have said, that industrial art should be encouraged and directed wisely and generously, in order that the engineer, the designer, the draughtsman, the architect, the worker in wood, ivory, and metals, the decorator, the artist, &c., may be better fitted to fulfil the duties of their several vocations in such a way as to keep the trade products on which they are employed at as high a level as possible; but it is also wise that in the public schools of a nation the elements of that peculiar education of the senses, the taste and the handiness which the study of drawing imparts, should be made a common possession of the million.

The narrower circle of home-life may, by this art-knowledge, be brightened and blessed. Even if the student should never attain any great facility or distinguished executive skill, the "taste" or love of the beautiful will have been trained and cultivated, and the result of this cultivated taste in forming and refining home-life is very beneficial. The want of education, and consequent lack of confidence and independence, compels people to follow others in beaten tracks instead of following their own inclinations. This is very evident in the furnishing of a house. Furniture, for example, is often bought because it is the kind of thing that is generally used, and placed in certain positions because it is the usual custom. In a home of taste the individual objects are not necessarily costly, but they are carefully selected and arranged in unusual and yet effective and harmonious ways.

Such a home is now far more common than it was, and for every one who is so fortunate as to possess a beautiful home there are a great many who sympathize and admire, hoping some day to be able themselves to do likewise.

Homes which are tastefully arranged have an elevating and refining influence on those who live in them, and are the means of keeping the young from seeking pleasure in so-called "places of amusement." "I mean to make my house as beautiful as I can," said a large manufacturer in the North of England, "so that my children may find no place more attractive than their own home." And he considered that the money he spent in pictures and decorations was well invested as a means of increasing the happiness of his family.

It is quite true that the extended system of art-education now made available throughout the country by the Government has been founded on a more utilitarian basis. It is admittedly intended primarily for the advancement of industrial art, and designed to secure our commercial eminence. But, as is the case in almost all wise measures, secondary advantages develop out of them; so has it been in the means taken to diffuse a knowledge of the principles and a practical employment of art. By the aid thus given to art-study, it was designed that we should be able to compete with the manufacturers of foreign countries, and not lose our hold upon the markets of the world. The Department of Science and Art was founded upon this economical and commercial basis, and grants of public money are made for the above-given reasons. It has been abundantly proved that the Department has done good work in this direction, that it has greatly improved the productions of our designers and craftsmen, and that the public money has been well invested. But it should not be forgotten that art-education has higher aims, and art-knowledge other and better results than these. The happiness of the community is not altogether dependent upon its commercial prosperity, and bright homes, giving evidence of a love for the beautiful, are at least as likely to create happiness among the people as increased incomes.

This commercial side of the question is, however, an important one, though its importance has been only gradually recognized by our statesmen. About 150 years ago Sir James Thornhill proposed his National Academy or School; and when, being asked, he modestly estimated that it would cost £3000 to start such a school, he was told by the statesmen of the day that the country could not afford it! Just fifty years ago a "school of design" was opened at Somerset House, under the management of the Board of Trade. This has grown into a separate Government Department, which spends £350,000 a year on the development in the nation of art-education.

All classes of society now have the opportunity of gaining art-knowledge, and may be made familiar with art matters; the standard of manufacturer and dealer is raised by the necessity laid upon them to satisfy the cultivated tastes and desires of thousands of customers who demand artistic products, and delight in them.

The national love of the pure and beautiful in art is proved beyond question by the most patent of facts—the delight felt by all the people in picture galleries and in our grand cathedrals in which the beautiful has been enshrined in stone and associated with worship. These cathedrals, conceived and designed by cultured minds, and evincing all the learning and genius of the most perfect artist, built up with consummate skill by the hands of well-trained workmen, perfect in every branch of craftsmanship, prove also the power of English minds to conceive, and of English hands to execute works of art of the very highest kind.

But apart from such considerations, we have refinement, taste, and love of the beautiful in nature shown in almost every village in our land. What traveller has not noticed the wonderful difference between the villages of the Continent and of our own country? The English cottage home, with its garden, and the roses and honeysuckle climbing over its porch, is in itself enough to prove that the English nation is worthy to receive all needful instruction and direction in art, and that every effort made to cultivate a love of the beautiful will be like seed sown in a fruitful ground, and will yield a liberal increase.

Our opinion that drawing should be not only a home-study but a home-joy has led to the preparation of these chapters for the "Home Teacher." We know that however widely schools of design may be spread, and however faithfully teachers may adapt their instructions to their classes, education is in reality an application of the mind of the individual to the matter of our study, and must be conducted mainly by ourselves. Much of course depends on our opportunities, more upon our use of these opportunities, and most of all, if we want to translate the simple and beautiful lessons of Nature into the language of art, must we employ the best powers of our mind and frame in the accomplishment of the task. To make art our own is to incline Nature to suggest or reveal to us the sweet perfection of her loveliness, and to lead us to purify and elevate our character; for, as Kingsley says, "It is only the pure soul that will perceive purity; the noble soul, nobility; the beautiful soul, beauty, whether in earth or in heaven itself." It is as an aid to this self-culture of the perceptive faculties that we have written—culture which enhances the value even of the useful by making it subsidiary to the adornment, exhilaration, and delight of our own hearts and the hearts of others, by engaging us consciously in refining endeavours to make our personal daily life and its surroundings, as far as leisure, power, and means permit, as full of beauty and of decorative taste as the appliances within our reach can make it. Art is good in itself as a joy, and as a culture it elevates men and nations. It reproduces, as far as human effort may, the glory and beauty of the exquisite forms, scenes, and suggestions of this perishable life by the power and for the purposes of the imperishable spirit; and it realizes in the sensible world, in type and symbol, the ideas of the supersensible universe, and brings them within the appreciating reach of those who, by being taught to admire, are brought to love.

HISTORY OF GREAT BRITAIN AND IRELAND.

CHAPTER XIII.

JAMES VI. AND I.—CHARLES I.—THE COMMONWEALTH—THE PROTESTANTS—CHARLES II.—JAMES II.—THE REVOLUTION—WILLIAM III. AND MARY II.—ANNE, FIRST SOVEREIGN OF GREAT BRITAIN AND IRELAND.

On Thursday morning, 24th March, 1603, James VI. of Scotland was proclaimed Elizabeth's heir and successor—James I., king of England, Scotland, Ireland, and France; and on Saturday night, in the Palace of Holyrood, that sovereign received from Sir Robert Carey, the youngest son of Lord Hunsdon, "the blue ring" which James had given to Carey's sister, Lady Scrope, to be used as a secret token of his accession, by Elizabeth's demise, to the throne of the island empire. The Scottish king was then thirty-seven, and had worn the circlet of sovereignty since he had been a year old. On the 28th official notice reached him, and announced the joy of the English and their impatience to see their king. Having appointed the Earl of Mar guardian of Henry, prince of Wales, Sir Alexander Seton of Prince Charles, the Earl of Linlithgow of Princess Elizabeth, and placed the government in the hands of the Privy Council, James arranged to leave his queen and children to follow him at their convenience, while he went at once to his new kingdom. On Sunday, 3rd April, he attended divine service in St. Giles's, and after sermon delivered a valedictory address to the people of Edinburgh, assuring them of his undiminished love. He was met by the Privy Council at Theobald's, Hertfordshire, entered London 6th May, and was crowned at Westminster 25th July. The Howards, and some others who had suffered in his royal mother's cause, were restored to their titles and estates, and an alliance was agreed upon between James and Henry IV. of France; Sir Robert Cecil was confirmed in the position he had held under Elizabeth as secretary of state, and was subsequently made Earl of Salisbury.

As James was a Scotsman and a Protestant, we need scarcely wonder that conspiracies were formed. Of these one was called the "Main" and the other the "Bye," being respectively chief and subsidiary plots. In the former, Sir Walter Raleigh, Lord Cobham, Sir George Brooke, and two others, were concerned. It had for its object the placing of Arabella Stuart, the king's cousin, on the throne with Spanish help. Sentence of death was passed, and all, except Raleigh, who was detained thirteen years in the Tower, were executed. Arabella Stuart was also imprisoned in the same keep, and died insane in 1615. The latter was planned to seize the king, to compel the dismissal of Cecil, and to procure a declaration of toleration alike for Catholic and Puritan opinion. Sir J. Markham and Lord Grey were implicated in it and suffered for it. A conference at Hampton Court was held from the 14th to the 16th January, under the presidency of the king, to inquire what, if any, ecclesiastical changes were requisite. The chief bishops and the leading Puritan ministers attended. James—not like those who looked on him as "God's silly vassal"—expressed his dislike of the Puritan sect. He would have the rules and orders of the church observed without relaxation. The Authorized Version of the Scriptures was one result of this conference, and a proclamation commanding all Jesuits and Seminarists to quit the realm was another.

James's first Parliament met 19th March, 1604. He expressed attachment to the church, and dislike both of Puritanism and Catholicism. His title as King of Great Britain was recognized and confirmed, tonnage and poundage were granted for life, witchcraft was declared felony, the penal statutes against Romanists were re-enacted, and the Commons asserted that their privileges as a House were held not of grace but of right. James withdrew himself from the confederation with Holland, and made peace with Spain and Austria. But as king and Commons combined to inflict penalties on professors of their faith, some Catholics formed a stern resolve to rid themselves of both. Robert Catesby, the originator of the plot, communicated it to Thomas Winter, a Gloucestershire gentleman, John Wright and his brother-in-law Thomas Percy, related to the Northumberlands. They joined to themselves Guido or Guy Fawkes, a Yorkshireman recently converted to Romanism, and formerly a soldier in the Spanish army in the Netherlands. Henry Garnet, chief of the Jesuits in Britain, administered an oath of secrecy to them, and they took the Holy Sacrament in fellowship. Other confederates were admitted, and in May they commenced their preparations. Parliament was to meet 5th November, 1605. Under the Parliament House they placed thirty-six barrels of gunpowder, covered with coals and wood. Fawkes had been told off to apply the match, and was all ready to do his nefarious work. But Lord Monteagle, a Catholic peer got a letter from his brother-in-law, Tresham, one of the band, warning him not to take his place among the members, for "they shall receive a terrible blow this Parliament, and yet they shall not see who hurts them." This he laid before the Council. James perceived "gunpowder" in it. The vaults were searched, Fawkes was arrested, avowed his design, and racked till he betrayed his accomplices. They had assembled in Warwickshire, intending to seize and proclaim the king's daughter as Elizabeth II., and to govern in her name. Catesby, the Wrights, and Percy were slain by the soldiery sent to arrest them. Tresham expired a prisoner in the Tower. The others were tried, condemned, and executed. Garnet was taken, and after an able defence died on the scaffold. Penal laws of greater severity were passed against Catholicism in England and Scotland. Efforts were made to secure the adoption of Episcopacy in the latter country, where the old line of bishops had become extinct by the death, in France, of James Beaton, archbishop of Glasgow. A legislative union between England and Scotland, supported by Lord Bacon but opposed by Sir Edward Coke, was rejected by Parliament.

James was anxious to keep on fair terms with Spain, and though the Gunpowder Plot had re-excited, along with dislike for Catholicism, the old antipathy to Spain, he regarded an alliance with that power as one which would be useful in preventing any outbreak of war in Europe. Not only did he offer by treaty to aid Philip IV. in preserving peace, but proposed, by the marriage of his son with the Infanta Maria Alethea, to unite the political interests of the two lands. He wanted money and foreign support, and thought both would be gained by this plan. Spain was willing to intrigue and inveigle but not to provide either. James had renewed the charter of the East India Company; introduced a "plantation" of Scottish and English settlers upon the forfeited estates in Ulster—having abolished tenure by tanistry and gavelkind; and had taken into favour Robert Carr, creating him Viscount Rochester (and afterwards Earl of Somerset). His pecuniary difficulties led him to levy "impositions." These were resisted, and the king, deeply in debt, with a heavy deficit before him, dissolved his first Parliament in 1611. He instituted the order of Baronets, and sold the dignity. Prince Henry, the darling of the people, died 6th November, 1612—some said by poison administered by Carr with the knowledge of the king, who was afraid that "he might be ready for the crown before he was willing to part with it." Carr, who had been suspected of having privily rid himself of an enemy in Sir Robert Cecil, and had since married the divorced wife of the Earl of Essex, was subsequently disgraced for participation, at the instigation of the countess, in the murder of Sir Thomas Overbury, for reproving their misdemeanours; and George Villiers (afterwards Duke of Buckingham) became favourite in his stead. In 1613 the Princess Elizabeth was married to Frederick V., the Elector Palatine, whose anxiety to obtain the crown of Bohemia led to the loss of his own throne, and originated the Thirty Years' War (1618–48). A second (known as "the Addled") Parliament met, 5th April, 1614, and was dissolved, 7th June, before a single measure had been passed, because it attempted to limit the power of the king, who believed that both by birth and divine right he was authorized to rule. The Commons refused supplies, and several members of the House were imprisoned. James had recourse to forced loans called *benevolences*—a means of raising supplies used by Edward IV. but declared against in Magna Charta—and the Star Chamber fined Oliver St. John £5000 for resisting the unlawful levy. In 1617 James visited Scotland, restored Episcopacy, and banished or imprisoned those who maintained the rights and privileges of the Presbyterian church.

Sir Walter Raleigh—who had taken part in many an expedition against Spain, had taken a decided position against making peace with that pertinacious enemy of England, proposed, without expense to the king, to land and lead a force of 2000 men in Spain, and warned the Duc de Sully that the object of Philip III. in his dealings with James was to act against France and the Netherlands—was, on a charge of having in politics "an English face but a Spanish heart," sent to the Tower, 15th December, 1604. Here he made it his prison pastime to compose for Prince Henry a "History of the World," to show him the providential government of events. After that prince's death the first part was published, 1614, but it was never completed. Knowing James's pecuniary straits, Raleigh, having paid £1500 to Villiers to procure freedom, moved Sir Ralph Winwood to lay before the king a scheme for the colonization of Guiana—suggesting that a gold mine therein would soon refill the royal treasury. On 26th August, 1616, a Commission (though unaccompanied by a pardon) was issued empowering Raleigh to act "as the king's lieutenant-general by land or sea" in leading that enterprise and settling that new country, of which, twenty years before, he had taken possession in Elizabeth's name. James stipulated—lest England should be embroiled—that he should go near no Spanish territory or injure any Spaniard, or his head should pay the forfeit. Off he hied to the Orinoco. In seeking for the mine, an expedition, undertaken while Raleigh was ill of a severe calenture (fever), was attacked by the Spaniards of St. Thomas town, who had been prepared by secret information from England for their arrival. The adventurer's son, Walter, was shot; Captain Keymis, the leader of the company, committed suicide; and Raleigh was compelled to return without so much gold ore as should have satisfied the king that he "had propounded no vain thing." By this time the Spanish match between Charles and the Infanta was afoot, and nearest to James's heart. Every other consideration must yield to this. His disappointment at Raleigh's return empty-handed in his sore need, and Gondomar's demand for condign punishment, whetted the king's rage against the man who—though the scourge of Spain and England's most capable surviving admiral—had circulated "Reasons why the King of Scots is unacceptable to the People of England," and defended Elizabeth's not nominating a successor. On Raleigh's arrival he was arrested, imprisoned, and brought, 28th October, 1618, before Chief-Justice Yelverton, who granted execution of the old sentence, and directed the warrant to be put in charge of Lord Chancellor Bacon. Next day—after saying to the sheriff, when feeling the edge of the axe, "It is a sharp medicine, but it cures all sorrows"—this renowned Englishman was executed in Old Palace Yard, and buried in the chancel of St. Margaret's Church.

But this Spanish business, after all, came to naught, for it meant menace to British Protestantism. Hence the people opposed the Spanish match. War broke out in Bohemia, which bordered on the Palatinate. The German Protestant princes chose Frederick for their leader, and Ferdinand called on the Catholic princes to unseat the usurper. England favoured Frederick, but James still longed for Spanish gold and help, and left his son-in-law unaided. Sir Horace Vere led a troop of English volunteers to fight for Frederick, but a Spanish force seized the Palatinate, and on the White Hill, at the battle of Prague, put to rout the followers of Frederick, 8th November, 1620. James then called his third Parliament, and asked supplies that he might negotiate with the sinews of war in his possession. Its members cautiously granted him small temporary supplies. Both King and Commons were out of humour. The latter resisted monopolies, and James yielded unwillingly. They complained against the sale of place and dignity, asserting that no mode of gaining supplies was valid unless duly authorized by them. Bacon, who had been made in 1619 Lord Chancellor and Viscount St. Albans, and was thought to be the king's adviser, was impeached, and found guilty of taking money from those whose suits were undecided. It was not sought to show that he had been influenced to give "corrupted judgment," but he was heavily fined, degraded, and imprisoned, 1621, and died in 1626. Further than this, the Commons objected to the king's favour for Spain and neglect of Protestant interests. He forbade them to meddle with affairs of state. They claimed the right of free speech; he affirmed they had that right only of the grace and permission of former sovereigns and himself. They protested in their journals "that the liberties, franchises, and jurisdictions of Parliament are the ancient and undoubted birthright of the subjects of England," 18th December, 1621, and next day the king, saying "he would govern the common-weal, but not by the common will," tore the entry from the book, dissolved Parliament, and punished Lords Oxford and Southampton, Sir Edward Coke, John Pym, and others. In accordance with a secret treaty, Prince Charles and the Earl of Buckingham set out to visit the Infanta. But in passing through Paris Charles was mightily taken with Henrietta Maria, daughter of Henry IV., and sister of Louis XIII. When the pair, who travelled as John and Thomas Smith, appeared in Madrid, March, 1623, they outraged Spanish notions of decorum, and the match was broken off. England rejoiced, and James (19th February, 1624) called a fourth Parliament, when, as Buckingham suggested, people were "in the giving mood." It granted £350,000 for the war declared against Spain and Austria, 10th March, impeached the Earl of Middlesex, lord treasurer, for bribery, and took Dr. Montagu, the king's chaplain, to task for preaching the doctrine of "divine right," when James suddenly prorogued it, 29th May. It was not summoned again. A treaty for the marriage of Charles, Prince of Wales, and Henrietta Maria was signed 12th November. Contrary to James's undertaking with the country, it contained provisions favourable to Catholicism. The king, afraid to meet the Commons, found himself with an expensive war on his hands and quite under the power of France. Money he could not get, and yet it was wanted for the Netherlands, for Denmark, and for fitting out an English fleet to sail against Spain. A joint expedition of 30,000 men had been agreed to be sent by England and France—under Ernst, count Mansfeldt, a German soldier whose sword was his whole estate—for the regaining of Frederick's lost principality. England was to furnish 12,000 men. These assembled at Dover and were taken to Holland in the winter time, but had neither provisions nor money. Frost set in, and cold and want produced disease. In a short time 9000 were incapable or dead. The whole plan collapsed, and the Palatinate was not regained till, by the Peace of Westphalia (or Münster), 24th October, 1648, it was restored by Austria to Frederick's son and namesake. James, who had, with reluctance and hesitancy, followed Buckingham's advice to this disastrous issue, was early in 1625 residing at St. Theobald's. Overtaken there with an ague, he died, 27th March, having been twenty-two years king of England. He was buried in Henry VII.'s Chapel, Westminster, where he had raised monuments over the remains of Mary his mother, and Elizabeth his grand-aunt—but where no monument was raised for him.

James was shrewd, though pedantic and self-opinioned. He had been trained amid controversy and religious contention, and had been flattered and be-fooled by "politicians." His life had been passed among intrigues and false-seeming. He was wary and selfish, and carried the dogmatism of the divine into the arena of public life. But he did not understand the people over whom he reigned, nor did he appreciate the changed circumstances of an age which had been taught by the poetry of Shakespeare, the philosophy of Bacon, the theology of Cranmer, Hooker, and Browne, the history of Foxe's Martyrs, and Holinshed's Chronicles, and which sought to realize a "Utopia" better than More's—by becoming "a nation serving God."

True kingcraft consists not in accomplishing the sovereign's will despite the people, but in shaping a policy with which the people sympathize, and carrying it out boldly and honestly. Britain was now before all things Protestant. Protestantism seemed to be crushed, persecuted, and doomed to defeat everywhere, yet the kings of Britain were forming alliances, political and matrimonial, with those who had stricken the heaviest blows against fredom of conscience. The nation upon whose scroll of fame the defeat of the Armada had been written, disliked to be "unequally yoked" with that Spain

which was but the secular arm of the Pope, and any union of political interests with Catholic France appeared treason to the King of Kings. The people had readily therefore granted subsidies for the war against Spain and in favour of the Elector Palatine, but when they found it was entered upon rather to gratify the rage of Buckingham than to secure the rights of their fellow-religionists, they resented the intrigue and resisted the impositions the war required. Charles I. had been taught the divine right of kings to ill advantage. Both James and Buckingham had led him to believe that "the end justifies the means," and the war against Spain had been inaugurated upon a specious perversion of truth—a statement that the Spanish match had been broken off because the prince would not become a Catholic. James's reign had been a long-continued contention that the duty of Parliament was submissively to vote supplies and to carry out the sovereign's plans. This had intensified the determination of Parliament to maintain that the new king should (1) acknowledge that the duly enacted laws of the land set limits to the prerogatives of the Crown, and (2) consent that the Commons, as the guardians of the liberties of the people, should have the right of free speech on all public concerns.

Such was the strained state of feeling between Crown and Commons when Charles I. came to the throne. The king immediately espoused, by proxy, Henrietta Maria, daughter of Henry of Navarre, and sister of Louis XIII., 1st May, 1625. She arrived at Canterbury, 13th June, and there the marriage contract was consummated. On 18th June the first Parliament assembled in London, but owing to the plague, then ranging, its members were anxious to adjourn speedily, and only proposed temporary measures—the granting of two immediate subsidies of £200,000, and of tonnage and poundage for a year. Charles construed this into an insult, and Buckingham, anxious to induce a rupture as an excuse for a dissolution, summoned them to meet again at Oxford in a fortnight's time. They met, but with resentment and suspicion brooding in their hearts. When Charles presented the question, "What shall we do for money for these wars?" they demanded redress of grievances, and he indignantly dissolved the House. He then raised money on forced loans, and sent a fleet to blockade Rochelle. The sailors declared they would rather hang or drown than fight against their fellow-Protestants, and the king wrote authorizing Pennington to compel obedience "even unto the sinking of the ships." The crews deserted, and the ships were manned by Louis XIII.'s recruits. A fleet of ninety vessels was fitted out to sail against Spain, in the hope that Spanish gold might replenish his empty exchequer. Buckingham, though Lord Admiral, sent Sir Edward Cecil (Viscount Wimbleton) on this hopeless errand, and without having faced a foe or procured a prize, the expedition returned in disgrace.

In 1626 Charles convened a second Parliament. The country was then getting divided into (1) those who supported the king's authority and (2) those who upheld constitutional government. Charles took great care to gain a Parliament favourable to his veiws, but the Commons would only grant subsidies on getting their grievances redressed. Charles refused. The commons impeached Buckingham for monopolizing the most lucrative offices of state, seizing a French ship on his own account, extorting £10,000 from the East India Company, and taking the English to fight against Rochelle. The king, to save his favourite, dissolved Parliament. By forced loans and the pawning of the crown jewels and plate, money was raised, and Buckingham was sent in person to aid the Protestants of Rochelle. He was unsuccessful, and Charles was unwillingly compelled to call a third Parliament. It voted five subsidies, provided the five provisions of their Petition of Rights were granted—(1) that no forced loans should be exacted, (2) that no one should be imprisoned for refusing forced loans, (3) that *Habeas corpus* should be respected, (4) that billeting of soldiers in private houses should be disallowed, and (5) that martial law should not be exercised. He assented, but did not consent, and evaded as far as possible every one of its provisions. Buckingham, while preparing for a fresh expedition to Rochelle, was assassinated by John Felton, 23rd August, 1628.

Charles selected as his chief advisers Archbishop Laud and Sir Thomas Wentworth—the former bent on securing uniformity, if unity could not be had, in the church, and the latter resolved on maintaining the supreme dominion of the king. Parliament met in 1629. It complained of illegal taxation, the increase of popery, and the favour shown to Arminianism. Sir John Eliot proposed that those who had suffered illegal distraints should be compensated, and the distrainers punished. Charles refused, while Eliot persisted. Finch, the Speaker, was held in the chair till the resolutions were passed which the popular party proposed. The king dissolved Parliament, and imprisoned and fined several of its members. Eliot died as a prisoner. Charles dispensed with Parliament for the next eleven years. Many old feudal but unlawful taxes were raised, and fines, confiscations, and extortions were enforced. Ship-money, which was originally a coast-town tax, was extended to inland property, and John Hampden refused to pay. By a majority of one Hampden lost his cause, and he, Cromwell, and many others resolved to leave the land where such injustice was possible, but Charles would not—although they had actually taken ship—allow them to quit England.

Wentworth had managed to make Charles absolute in Scotland by intense tyranny; but when Laud suggested, Wentworth seconded, and Charles decreed that in 1637 Scotland should employ in its churches a new liturgy, North Britain rose in rage. Jenny Geddes, in the Church of St. Giles, threw her stool at the officiating Dean, refusing to allow prayers to be read in her hearing. The uproar spread, Edinburgh stood to the opposition, and Scotland in general rejoiced in the Edinburgh movement. Charles persisted, Scotland resisted, and a National Covenant was in 1638 adopted to maintain religious independence. The Scots placed themselves under General David Lesley, who had distinguished himself in the German wars. Charles advanced in anger to the Scottish Borders in 1639, but his exchequer was empty and his troops unwilling to fight. A treaty, referring Scotland's ecclesiastical affairs to a new Assembly and Parliament, was concluded. Wentworth, who was created Earl of Strafford, had been—highhandedly, yet beneficially in many things—ruling Ireland with a rod of iron, but was now recalled from his task there to advise with Charles, for the Scots interpreted the treaty one way and the king another. He counselled the calling of a new Parliament, and in 1640 one met; but instead of being ready to rush to war with the Scots, the Commons wished Charles to agree to govern better, and to make peace with his Presbyterian subjects. In three weeks the "Short" Parliament was dissolved. The Scots crossed the Tweed, overran and occupied the north of England, and at Newburn, near Newcastle, defeated the king's troops, driving the "pepper" army before them out of Durham, and he was compelled to buy a peace. Hence the "Long" Parliament was called, and assembled in November, 1640. It went to work roundly, setting free those who had been imprisoned for political offences, and impeaching the king's advisers. Strafford was arraigned under a bill of attainder, and condemned for having "arrogated an authority beyond what the Crown had ever lawfully enjoyed." With much reluctance, Charles—who had promised never to do so—signed his death-warrant, and he was beheaded 12th May, 1641. Laud was accused of treason, and committed to the Tower, 18th December, 1640, and here, during a long imprisonment, he wrote a full and on the whole faithful account of the troubles and trials of his personal, ecclesiastical, and political life. He was charged with high treason, and defended himself with courage and ability. The judges indicated that no legal treason had been proved, and Parliament, by a tyrannical abuse of power, issued an ordinance for his execution, which took place 16th January, 1645. Soon afterwards Episcopacy was abolished, the Presbyterian Directory superseded the liturgy, and the clergy who refused to conform to the new order of things were ejected from their livings.

Early in 1641 an Act was passed (1) to prevent any Parliament from sitting for more than three years or (2) more than three years elapsing without the assembling of a Parliament, and (3) that no Parliament should, without its own consent, be adjourned or dissolved in less than fifty days, dating from the opening of the session. Owing

to a rumour of an army plot for the release of Strafford and the destruction of his enemies, Charles, heart-sick, had assented to a bill depriving himself of the right to dissolve Parliament without its own consent, 10th May, 1641. No strong difference of opinion prevailed among the Parliamentary party till after the publication of the "Grand Remonstrance on the State of the Nation" presented to the king. The more moderate members opposed this, and had Charles prudently engaged then to rule in a constitutional way he would have gathered a majority around him. But he was imperious and ill-advised, and when the attorney-general, in the House of Lords, charged Lord Kimbolton (afterwards Earl of Manchester), and Hampden, Pym, Hollis, Haselrig, and Strode with high treason, and Charles went in person to the House of Commons to demand delivery to him of its accused members, he became highly unpopular. The Commons, concluding that he really intended to crush the liberty of Parliament and the people, demanded that he should denude himself of his royal prerogative as supreme commander of the army, put in their hands the fortified places in the kingdom and the charge of the militia —which was then the only authorized British army. This overt attempt to usurp a king's authority, Charles haughtily refused, and left London—never to return to it till he was led there as a prisoner, not to the throne but to the block.

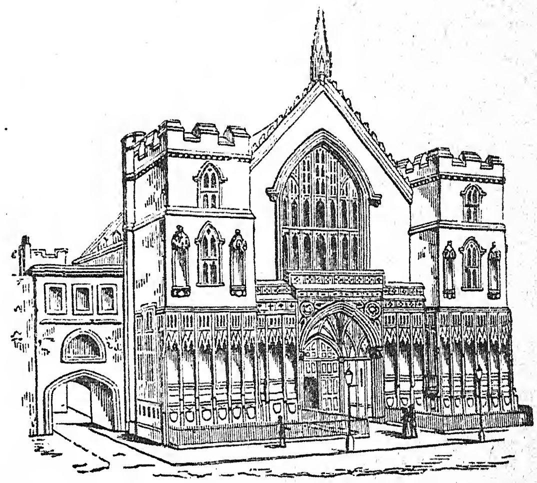
It would be impossible to give details of the diverse incidents of the several battles fought in the Civil War. We shall present in chronicle-form the main matters—date, place, commanders, and results:—23rd October, 1642; Edgehill. Charles I., Prince Rupert, and Robert Bertie, earl of Lindsey, with an army 12,000 strong, met Essex with 10,000 men on the edge of that table-land in the north of Oxfordshire which looks down on the levels of Warwick. The king fired the first piece of artillery; Lindsey, as general-in-chief, led the king's centre; Rupert, as lieutenant-general of the horse, was on the right, and Colonel Wilmot on the left. Essex commanded his centre; the left and right wings were routed. The Earl of Lindsey was mortally wounded. The battle was indecisive. The king retired into Oxfordshire. Essex, leaving Warwick, proceeded to London. A party placed by him under Colonel Denzil Hollis to protect the way to the Metropolis, was, pending a proposed treaty, attacked by Prince Rupert from Colnbrook, and defeated, 12th November, 1642. Two days afterwards 24,000 men appeared for the Parliament on Turnham Green, but Essex remained on the defensive, and abstained from attacking the Royalists. In the spring of 1643 the queen brought over from Holland, in four foreign ships, a force she had raised there. This act of invasion greatly exasperated the people. Parliament proposed to come to terms, but Charles vacillated, and at length Essex marched to besiege Reading, which had been fortified in the king's favour. In ten days it capitulated, 27th April, 1643. Sir Ralph Hopton—who in Charles's interest gained a victory, 19th January, 1643, over Ruthven, the governor of Plymouth, who held it for the Parliament—inflicted a severe defeat on the Parliamentary forces led by Henry Grey, earl of Stamford, and General Studleigh, at Stratton (in Cornwall), 14th May. Seven days afterwards, however, Sir Thomas Fairfax, with 1100 men, overcame 3000 Royalists under General George Goring at the storming of Wakefield. On 14th June Prince Rupert was successful in a skirmish with two regiments of Essex's forces, on Chalgrove field, near Oxford, where John Hampden received a mortal wound, of which he died a week afterwards. William Cavendish, marquis of Newcastle, on 30th June, put the insurgent army, commanded by Lord (Ferdinand) Fairfax, to rout at Atherton Moor, near Bradford, in Yorkshire. Sir William Waller (brother of the poet Edmund Waller) who had distinguished himself in the western and southern counties, lost his prestige on being partially defeated by Prince Maurice, 5th July, at Lansdown, near Bath, and wholly by Lord Henry Wilmot, 13th July, at Roundway Down, near Devizes. The royal cause was still further successful on 27th July by the surrender to Prince Rupert of the seaport city of Bristol. On the next day, however, the tide of war was turned, when Colonel Oliver Cromwell defeated General Cavendish—who was slain in the encounter—at Gainsborough, Lincolnshire. Charles proceeded from Oxford to Gloucester, which was garrisoned under General Edward Massey with 1500 men. From 10th August, when the king summoned it to surrender, till 6th September that city was defended with matchless bravery. By forced marches, Essex made his way from London towards Gloucester, the king's army relinquished the siege, and the city was relieved. Essex, on his return, was, on the way to Reading, attacked by Prince Rupert, and Cavaliers and Roundheads had a sharp skirmish for some hours together. He halted at Hungerford. The king, managing to reach Newbury in Berks before him, intercepted his progress towards London, 19th September, and next day, the earl having encamped on Bigg's Hill, battle was waged. Courage of the highest order animated both armies, and, regretted by all parties, Robert Dormer, earl of Carnarvon, the Earl of Sunderland, Lucius Carey, and Lord Falkland, among the Royalists, perished, but victory attended the Earl of Essex. A Royalist rout took place at Winceby, near Horncastle, Lincolnshire, where Edward Montague, earl of Manchester, and Cromwell defeated Sir John Henderson, 11th October. In his straits the king recalled his English regiments from Ireland. These, under the command of Sir John Byron, besieged Nantwich, Cheshire. Sir Thomas Fairfax hastened to the aid of the town, and on 25th January, 1644, totally defeated the Anglo-Irish—many of whom actually recruited the Parliamentary forces. He also totally routed the Cavalier forces under Colonel Bellasis at Selby, in Yorkshire, on 11th April. Sir William Waller retrieved his reputation at Cheryton Down, near Alresford, in Hampshire, by overcoming Sir Ralph Hopton, 29th March, but was, when attacked by Charles I. and Thomas Wentworth (Lord Cleveland) at Copredy Bridge, Oxford, unable to resist repulse. Now difficulties thickened. The Scots had engaged in a Solemn League and Covenant to extirpate popery and prelacy. Sir Henry Vane, "young in years but in sage counsel old," on the part of the Parliament, entered into a treaty of alliance on this understanding. To this, on 25th September, 1643, at St. Margarets, the Presbyterian Parliament of England swore fidelity, and therefore, on 19th January, 1644, Alexander Lesley entered England with a Scottish army. He marched on Newcastle and summoned it to surrender. The governor and garrison refused, and being straitened for supplies, the Scots resolved on passing further south. Essex and Waller, it had been arranged, should blockade Charles in Oxford; Manchester and Fairfax were to join the Scots in investing York. Prince Rupert marched 20,000 men to the aid of the besieged Earl of Newcastle, who commanded the army in the north. York being thus re-provisioned and strengthened, the prince on 2nd July resolved to fight. The Parliamentarians extended their forces from Marston to Tockwith; the Cavaliers occupied the moor. Rupert burst upon the right wing, chased and slaughtered the Scottish army, and left the two centres to fight with the strenuous valour of men in earnest. In his absence Fairfax and Cromwell charged among them, and rout and ruin betook the Cavaliers. Newcastle rushed to Scarborough and fled to the Continent. Rupert made off to Chester. The Roundheads took 1500 prisoners, 100 banners, and all the artillery; more than 4000 fell on the field, and thus the northern half of the kingdom was reft from Charles's rule.

The queen, who had gone to Exeter in April, gave birth to a princess there during the time it was besieged by Essex. Charles, eager to raise the siege, marched westward. Meanwhile the queen fled to Falmouth and thence to France, and never saw Charles again. Essex was driven into Cornwall, where the Royalists cooped him up and almost forced him into capitulation. This he avoided by leaving Skippon in command and hastening to London. Thither Charles resolved to proceed, but three armies were called out to defend the capital. Essex, Manchester, and Waller were in command. Some differences had arisen between the Presbyterians and the Independents, and Manchester and Cromwell encountered the king at Newbury, where both parties a second time made hot contest, 27th October, 1644, though without decisive results. Meantime—to make reprisals against the Scots for their invasion of England, and to aid his sovereign—James Graham, marquis of Montrose, took arms against the Covenanters, who, though led by Lord Elcho, were completely

defeated in an engagement at Tippermuir, near Perth, 1st September, 1644. Lord Burleigh also, ten days subsequently, suffered a reverse at Aberdeen, and defeats were inflicted on the Covenanters successively at Inverlochy, in Inverness-shire, when led by Archibald Campbell, marquis of Argyle, 2nd February, 1645; at Auldearn, under General Hurry, 9th May; at Alford, Aberdeen, under General Baillie, 2nd July; and more disastrously, under the same leader, on 19th August, at Kilsyth, Stirlingshire, when 5000 were slain in the subsequent pursuit, and Montrose became master of Scotland till General Lesley, hearing of his intention to pour this victorious army into England in the king's behalf, hurried into Scotland, and on 13th September surprised Montrose at Philiphaugh before he had time to form his line of battle, and wrested from him the fruit of his six previous victories. Before this had happened, Charles had taken Leicester by storm, and Taunton had been besieged by the Royalists. Fairfax, while encircling Oxford with his troops, was commanded to follow the king. He had reached Hall House, near Harborough, when Fairfax and Cromwell came upon the rear of his army near Naseby. On 14th June, on the table-ground of Broad Moor, Crown and Commons encountered, with the result, as Cromwell reports, that "after three hours' fight, very doubtful," they "at last routed his (the king's) army, killed and took about 5000," and in addition seized among the spoil Charles's cabinet. The secret intrigues revealed by its contents did more than a dozen defeats to destroy sympathy with the royal cause. Naseby practically closed the first civil war. Fairfax defeated the Royalists under Lord George Goring at Langport, in Somersetshire, 10th July, 1645; Bridgewater capitulated to him on the 23rd, and after a long investment Bristol was taken by storm 11th September. Colonel Poyntz, pursuing Charles—then making his way to join Montrose in Scotland—came on the rear-guard of his forces on Rowton Heath, near Chester. Sir Marmaduke Langdale promptly turned and fought, but was defeated. This, however, gave Charles the chance of escaping to Denbigh Castle, whence he went to Newark, where, after a fierce scene of mutual recrimination, Prince Rupert and his brother Maurice left the king's service. Charles then sought refuge in Scotland, and from 6th May, 1646, to 30th June, 1647, he was under their protection. On the latter date the Scots, under treaty, marched from Newcastle, leaving Charles in the hands of nine commissioners from the Commons, who removed him to Holmby House in Nottinghamshire. Here he remained, while various political intrigues were carried on, from 16th February to 2nd June, when Cornet Joyce removed him to Royston, and he was thereafter retained under the surveillance of the army. Many endeavours in the way of conciliation were made, and Charles was allowed to reside in Hampton Court Palace. Thence he escaped to Carisbrook Castle, where also much political mediation went on, and while he was there the Commons resolved to "settle the commonwealth without the king." At daybreak, 30th November, 1648, Charles was taken from Hurst Castle to Windsor. On the day of his arrival there it was resolved that he should be brought to trial. On 2nd January, 1649, the Commons declared that in making war against the Parliament Charles had been guilty of high treason, and appointed a high court of 150 commissioners to try him. On 19th January he was lodged in St. James's Palace, and next day the court was held at Westminster Hall, 69 members being present, with John Bradshaw as president. Charles refused to plead. On the 27th the king, being brought in, was informed by Bradshaw that the court had agreed on the sentence. This was read, "that his head should be severed from his body." The king desired to speak, but was not permitted. Sentence of execution was signed by John Bradshaw, Thomas Grey, Oliver Cromwell, and fifty-six others on the 29th, and on the 30th Charles left St. James's surrounded by soldiers for a scaffold raised before the Banqueting House of Whitehall. Nearly three hours he passed in prayer, partook of the sacrament, and went forth to die. To the crowd he declared that the people mistook the nature of government, for people are free under government not by being sharers in it, but by the right administration of the laws of a realm. To Bishop Juxon, Charles handed his cloak and gave his order of St. George, then laying his head upon the block and stretching out his arms as a sign that he was ready, the masked headsman struck a single blow, and all was over. With a shudder and a groan the assembly saw the end of him who

> "Nothing common did or mean
> Upon that memorable scene."

As a man Charles was affable, temperate, and religiously inclined, of cultured understanding and good taste; but as a monarch he was unscrupulously insincere, neither just, generous, nor constitutional. Lord Clarendon calls him "the worthiest



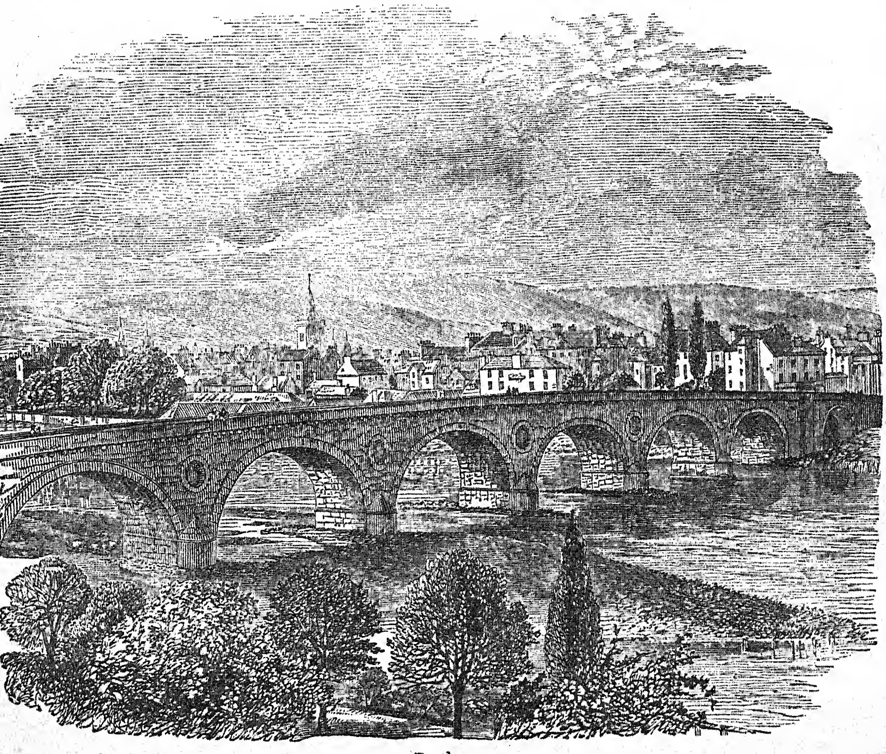
Westminster Hall.

gentleman, the best master, the best friend, the best husband, the best father, and the best Christian that the age in which he lived produced," and Lord Macaulay censures the political and religious zealots who "had so contrived their revenge, that the very man whose whole life had been a series of attacks upon the liberties of England, now seemed to die a martyr in the cause of these liberties." While "Icon Basilikē" and "Iconoclastes" survive, controversy regarding the life, character, and death of Charles I. is likely to continue.

After the "martyrdom" of Charles I. the Rump Parliament—which, in order to secure the condemnation of the king, had been, by Cromwell's orders, cleared of all doubtful and moderate members by "Pride's Purge," 6th December, 1648—forming now but a remnant or fag-end of what the Commons House had been, declaring that a House of Lords was "useless and dangerous," and that goverment by a king or single person was "unnecessary, burdensome, and dangerous," proceeded to abolish both. A Council of State consisting of forty-one members was appointed, with Bradshaw as president and John Milton as Latin secretary. Fairfax and Cromwell had charge of the army, and Robert Blake of the navy. The crown and the church lands were sold, and some of the more distinguished of the Royalists were punished—the Duke of Hamilton, Lords Holland and Capel suffering death. An Act constituting England a commonwealth instead of a kingdom was proclaimed in London, May, 1649. Scotland, which had no hand in the sovereign's death, maintained the monarchy, and on 5th February, 1649, Charles II. was proclaimed king, on condition that he should undertake to observe the National Covenant. The Marquis of Montrose made a gallant attempt to secure the accession of the king free from these restrictions. He landed with 700 men in Orkney, crossed to the mainland, and advanced into Sutherland; but Colonel Strachan with a body of cavalry at Corbiesdale, in Ross-shire, on 27th April, 1650, discomfited him and dispersed his forces. In a few days he was delivered by Macleod of Assynt to General Lesley, who brought him to Edinburgh, where he was put in gaol, and—on a death-sentence passed upon him in 1644—hanged at the Lawmarket on a gibbet 30 feet high (21st May) and thereafter quartered.

Ireland, too, which from the terrible day of the massacres of the Protestants, 23rd October, 1641, had been full of bloodshed and disorder, declared in favour of Charles II., who was proclaimed king by James Butler, earl of Ormonde. It seemed as if Ireland would be entirely lost unless instant energetic measures were taken. Cromwell was made Lord-lieutenant. Collecting an army of 12,000 men, and with a great array of artillery, he set off for Dublin. Prior to his arrival, Jones, the governor of Dublin, opposing Ormonde's attempt to storm the city, inflicted a severe defeat on the Royalists, slaying 3000, and taking 2000 prisoners on 2nd August. On Cromwell's landing, 15th August, he proceeded to Drogheda, besieged it, on the third assault, on the 11th September, took it, and ordered every person bearing a weapon to be put to the sword. The officers of 140 soldiers who entrenched themselves in the tower were "knocked on the head," the men were decimated, and the remainder shipped off to serve as slaves in Barbadoes. A month afterwards, at Wexford, a similar scene of slaughter ensued. Cork, Kinsale, and Youghal speedily succumbed, and when Cromwell had lain a few months in winter quarters he proceeded, January, 1650, to reduce several other cities. Kilkenny soon opened its gates, but Clonmell resisted gallantly. Owing to his being recalled to take command of the army in Scotland he left his son-in-law, Ireton, the task of subjugating Erin. This he continued in the same style, finishing by the capture of Limerick after a long siege, 27th October. Ireton died of the plague, 15th November, 1651.

Charles, on learning the state of affairs in Ireland and the failure of Montrose in Scotland, accepted the Scottish proposals (1) to adopt the Covenant, (2) discourage Romanism, (3) govern by parliaments, and (4) maintain the Presbyterian system. Fairfax hesitated to proceed against the Presbyterians. Cromwell accepted the task, crossed the Tweed, met the Scots under Lesley at Dunbar, 3rd September, 1650, completely scattered them—taking 10,000 prisoners, while 4000 fell on the field. This made Cromwell master of the Scottish Lowlands. He then occupied Edinburgh, passed into Fife, took Perth—near which, at Scone, Charles II. had been crowned, 1st January, 1651—and was bending his course towards Stirling, where a Scotch army was assembled. These forces moved onwards into England in the hope of gathering the Cavaliers to the king's standard. Cromwell pursued them. Battle became inevitable at Worcester, 3rd September, 1651—just a year after the "Dunbar drove"—where the Scots, on being compelled to enter the city, had



Perth.

their own guns turned on them, and after about five hours' fighting Cromwell obtained the "crowning mercy" of success. Charles escaped, wandered about in disguise for some time, but at length secured a passage in a coal-boat from Shoreham, in Sussex, to Fécamp, in Normandy.

General Monk, who had gone northward on Cromwell's staff, was left in Scotland to complete the work of subjugation. He took Stirling Castle and subdued Dundee, carried the war into the heart of the Highlands, and crushed the Royalist cause in the north. For a time Scotland had rest and prosperity, though by Monk's orders Cotterell, one of Cromwell's colonels, suppressed the General Assembly in July, 1653—rent by resolutioners and remonstrants. He marched its members under military escort a mile beyond Edinburgh, and dismissed them with a caution. Thirty Scottish members were allowed to sit in the Commonwealth Parliament, whose authority was now paramount in Britain. Jersey, Guernsey, Scilly, and the Isle of Man were reduced, and the American Colonies were brought under allegiance. The fleet, indeed, had revolted and offered its services to Prince Rupert, but the Portuguese having sheltered it were compelled by treaty to repair all damages and repay all expenses incurred by England in the hostilities required to recover the fleet, January, 1653. Holland also received Royalist fugitives, and refused to enter into alliance with the Commonwealth. In retaliation parliament passed the Navigation Act, October, 1651, prohibiting the importation of goods except in English vessels or those of the country where the goods were made. This led to war. Before it was declared a naval action occurred in the Downs between Blake and Van Tromp, 19th May, 1652. Then followed a sea-fight off Plymouth, 16th August, between Sir George Ayscue and Admiral De Ruyter. In the Downs Blake defeated De Ruyter and De Witt, 23rd September, but Van Tromp repaid the defeat, 20th November. Blake and Van Tromp met again, off Portland, and after fighting from the

18th till the 20th February, 1653, Blake seized eleven Dutch war-ships and thirty merchant vessels. Van Tromp rallied, and was encountered, 2nd and 3rd June, off North Foreland by Monk, Deane, and Blake, when nineteen ships and 1300 men were taken. Once more the mettled Dutchman took the sea, and General Monk met him off Texel, 31st July. In this engagement Van Tromp was slain and great loss was suffered on both sides, though England won the day.

Growing jealous of the power of the army, Parliament tried to curb and reduce it. That they might retain their seats a Perpetuation Bill was brought in, reserving to present members their places, and giving them (who were mainly Presbyterians) a veto as regarded newly-elected members. Cromwell with 300 soldiers turned them out of doors, and thus, by an Act not less tyrannous than that of Charles, the Long Parliament came to an end. The Barebones (Inde-

Dissolution of the Long Parliament.

pendent) Parliament, elected under Cromwell's influence, met, but was not subservient enough. A council of officers, by an ordinance named "the Instrument," made Cromwell Lord Protector, 12th December, 1653. France and Spain accepted the change readily. He made peace with Holland, 5th April, 1654, summoned a Parliament, 4th September, consisting of 400 members for England, 30 for Scotland, and 30 for Ireland. They were intractable, and it was dissolved, 22nd January, 1655. It had not voted supplies, and Cromwell levied a tax of £60,000 a month. George Cony, a merchant, refused payment and was imprisoned, but ultimately consented and was released.

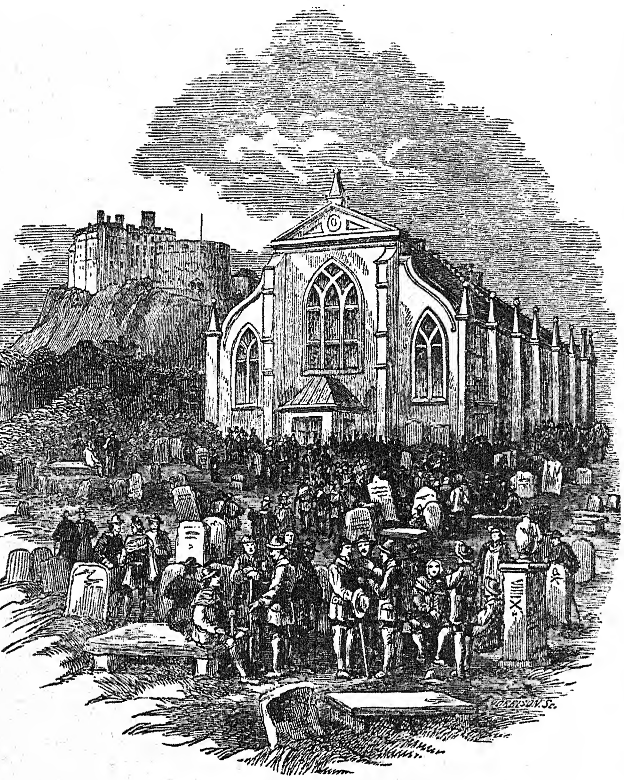
Cromwell's administration was vigorous. Commerce flourished. He maintained the dignity of the country abroad. Louis XIV. called him "brother," and Mazarin made a treaty with him against Spain, agreeing that Charles II. should not be allowed to live in France, and making Dunkirk an English dependency. His interposition in behalf of the Vaudois, and his insisting that France should join him in preventing the Duke of Savoy from persecuting the Protestants of Piedmont, was noble and successful. The army he sent to act with France against Spain in the Netherlands won fame throughout Europe. Great victories at Algiers, Cadiz, and the Canaries gave glory to England's flag, and Jamaica, taken by Penn and Venables, has since 1655 remained in possession of Great Britain. He divided England into twelve military districts with arbitrary powers. Each of his four Parliaments he summarily dissolved. His House of Peers was not a success. He was offered the crown by the Commons, but (probably) refused it from fear of the army. Conspiracies by the "Levellers" were specially suppressed, and plots for his assassination grew rife. Domestic sorrows added to his troubles. He was seized with ague, and died at Whitehall, 3rd September, 1658.

On his death his son Richard was proclaimed Protector. He summoned a Parliament, but by a cabal of army officers was induced to dissolve it and to abdicate, 25th May, 1659. The army reinstated the Long Parliament. It met, but was again dispersed at the bayonet's point. Then the Wallingford-House Cabal elected a Committee of Safety, 13th October. General Monk, who apart from the intrigues of party had watched the progress of events, declared for a free Parliament, advanced to London, and recalled the Rump, who issued writs for a new Parliament and dissolved of their own will, 16th March, 1660. Parliament met 25th April, and contained a large number of Royalists. Monk, who had become commander of the forces, entered into correspondence with Charles. He issued the Declaration of Breda, promising but not binding himself to amnesty and toleration. Parliament voted that Government should be by King, Lords, and Commons, and amidst the wildest joy Charles was invited to occupy the throne of his fathers.

Beginning his reign with moderation and clemency, Charles proclaimed freedom of opinion, selected his Council from Royalists and Presbyterians, and passed an act of pardon—excepting from its operation the regicide judges and some irreconcilable republicans. Monk was made Duke of Albemarle; Hyde, his confidential adviser, was created Earl of Clarendon, and the standing army, except Monk's Coldstream Guards and the soldiery garrisoning Dunkirk, was disbanded. The Convention or Restoration Parliament, after fixing the annual revenue of the king at £1,200,000, was dissolved 29th September, 1661. It was supposed that Charles would be an easy sovereign, and that the nation need fear nothing opposed to political and religious freedom. The clergy were restored to their benefices, and the bishops to their sees. A conference was held at the Savoy between the Episcopalians and the Presbyterians (April to July) to see if such changes could be made in the liturgy as would settle all differences and enable both to hold office in the church. It failed to effect a fusion. Charles was crowned 23rd April, 1661. Parliament met 8th May, and Charles began his endeavours to enforce Episcopacy upon the nonconformists. The Corporation Act, requiring all municipal officials to be in full communion with the Church of England, was passed 20th December, 1661. On 21st May, 1662, Charles II. married Catharine of Portugal, receiving Bombay and Tangier as her dowry. The Act of Uniformity, making assent to the Book of Common Prayer essential to holding ecclesiastical preferment, was passed and enforced on St. Bartholomew's Day, 24th August, 1662. When nonconformists tried to open places of worship, the Conventicle Act—disallowing any worship except that in accordance with the liturgy—was passed, 17th May, 1664; and next year the Five Mile Act—prohibiting nonconformists to come within 5 miles of any town sending members to Parliament—enabled the church to retaliate on her former persecutors.

Though the Marquis of Argyle had crowned Charles II. at Scone, on going to London to congratulate the king he was committed to the Tower, and after a five months' detention there, sent to Scotland to be tried for compliance with Cromwell's rule. He was condemned and beheaded as a traitor at the cross of Edinburgh, 27th May, 1661. The Rev. James Guthrie, minister of Stirling, was next executed —for disowning the king's authority—1st June, and Lord Warristoun, who had drawn up the National Covenant, was entrapped in Rouen, taken to the Tower, and conveyed to Edinburgh, where without trial he was put to death, 22nd July, 1663. The Rev. James Sharp of Crail was intrusted with the re-establishment of Episcopacy in Scotland, but one-third of the clergy demitted their charges rather than yield. Then began the Covenanter's struggle—the rising at Dalry in Galloway, the surprise of Sir James Turner at Dumfries, the progress through Ayrshire, the march towards Edinburgh, and their defeat by General Dalziel amid the snowdrifts of Rullion Green, 28th November, 1666. Next came the torture and execution of Hugh Mackail, 22nd December; the shipping off of Conventiclers as slaves to Barbadoes; the sending out of the "Highland Host" to harry the "Covenant folk," the murder of Archbishop Sharp on Magus Muir, 3rd May, 1679; the skirmish at Drumclog, 1st June; the battle of Bothwell Bridge, 23rd June; and the

immurement of 1200 prisoners in Greyfriars Churchyard. The killing-time (1679–88) succeeded, when the Duke of York, as governor of Scotland, excelled his predecessors in cruelty. Richard Cameron was slain in fight at Airdsmoss, near Cumnock, 22nd July; Hackston of Rathillet was barbarously executed in Edinburgh, 29th July, 1680; Donald Cargill was hanged at Edinburgh, 27th July, 1681, while James Renwick, author of the Sanquhar Declaration, and



Greyfriars Churchyard.

chief of the organized societies, the last martyr for the Covenant, was executed 17th July, 1688, in the Grassmarket, Edinburgh.

But we must retrace the line of time, and notice the last grant of subsidies to the sovereign made by convocation; the repeal of the Triennial Act; the sale of Dunkirk to the French; the second Dutch war, in which Opdam was defeated off Lowestoft, 3rd June, 1664, by the Duke of York; the great plague of 1665, followed by the great fire of 1666; the declaration of war by France; the dismissal and flight of Clarendon; the negotiation by Sir William Temple of the triple alliance of Sweden, Holland, and England, against France, to oppose Louis XIV. in Flanders; the ministry of the Cabal cabinet—*C*lifford, *A*rlington, *B*uckingham, *A*shley, and *L*auderdale; and the secret treaty of Dover—by which, for a pension of 3,000,000 livres, Charles bound himself to profess Catholicism and to make war on Holland. War was declared, the Duke of York was received into the Roman Church, and between him and De Ruyter a naval engagement took place at Southwold Bay, 28th May, 1672. Charles seized £1,300,000 in the exchequer. Parliament met and compelled Charles not only to withdraw the Declaration of Indulgence, repealing all Acts against Nonconformity and Catholicism, but to ratify the Test Act, compelling sacramentarian connection with the Church of England. The Cabal was dissolved in 1673. Peace was concluded with Holland in 1674, and a second secret treaty was entered into with Louis in 1675.

The Titus Oates (pretended) revelations of a Romanist plot to assassinate the king led to the exclusion of Catholics from Parliament, the execution of Earl Stafford, a Plantagenet, and many other (innocent) persons. The informer had a pension of £1200 a year conferred on him. Thomas Osborne, earl of Danby, prime minister, was impeached for bribery and collusion with Louis XIV. Charles dissolved the "pension" Parliament, and Sir William Temple, who negociated the Treaty of Nimeguen, replaced Danby. The elections to the new Parliament went against the court. The Privy Council was reconstituted, and from it the cabinet was formed. The Habeas Corpus Act was passed, and to prevent the passing of a Bill to exclude the Duke of York from the succession, Parliament was dissolved 1679. The next Parliament was prorogued immediately on meeting, by the king's own act. The ministry resigned. Rochester and Godolphin took office. Monmouth, Charles's base-born son, returned from Scotland, but was depatched to Holland, while York was sent northwards as Lord High Commissioner — a Romanist to lord it over Presbyterians. In February, 1680, James was presented as a "Popish recusant," but the preceedings were quashed. Monmouth made a progress as a prince of the blood. Charles's fourth Parliament refused to vote supplies unless the York Exclusion Bill was passed. It was dissolved 18th January, 1681, and a new one called at Oxford 21st March, but was dismissed without doing anything eight days afterwards. Plunket, the Roman Catholic archbishop of Armagh, was (unjustly) condemned to death, and executed 1st July, and Stephen College, "the Protestant joiner," 31st August. Shaftesbury was indicted, but a "true bill" was not found. In 1682, William of Orange visited Charles to ask help against Louis XIV., but the French king had secured Charles's neutrality by a large bribe. James, to counteract the effects of William's visit, had an interview with his brother. Monmouth was arrested, bound over to be of good conduct, and ultimately banished to Holland. Thither Shaftesbury also fled, and died there January, 1683. A proceeding, "*quo warranto,*" was instituted to compel corporations to show "by what right" they exercised their privileges. Most of them were declared invalid by Judge Jefferies, and new charters had to be taken out and paid for. A confederacy of Whig leaders, known as the Rye-House Plot, was formed. William Lord Russell and Algernon Sydney were tried and executed for complicity in it—the former 21st July, and the latter 7th December, 1683. England—by Louis's subsidies, Charles's bribery, and his use of a standing army—was gradually being lowered into a French province, when the king was seized with apoplexy, and after receiving (secretly) the Romanist sacrament, died 5th February, 1685.

James II., aged fifty-one, who had married Mary d'Este of Modena, was proclaimed 6th February, and crowned 23rd April, 1685. Oates and Dangerfield (who had promoted the Meal-Tub Plot) were convicted of perjury, whipped, and imprisoned, and Richard Baxter was tried, convicted by Judge Jefferies, heavily fined, and kept in prison eighteen months. Parliament met 19th May, and settled on the king for life tonnage and poundage. The Scots rose in insurrection under Argyle, who was executed. Monmouth invaded England, landing at Lyme, Dorsetshire, 11th June, gave himself out as defender of the Protestant faith, claimed the throne, and set a price upon the head of James, duke of York. He was encountered by Lord Feversham at Sedgemoor, near Bridgewater, 6th July, defeated, forced to flee, taken, sentenced to death, and executed 15th July, 1685. His adherents were ruthlessly punished by Colonel Kirke and by Judge Jefferies in "the Bloody Assizes" held at Winchester, 7th August. A right to dispense with the penal laws against Dissenters was claimed and exercised by the king 21st June, 1686, and several Romanists were appointed to various offices in the state. An ecclesiastical commission was set up; it suspended Compton for preaching against the court; Massy, a Romanist.

was made dean of Christ Church, Oxford; 13,000 troops were assembled on Hounslow Heath to overawe London; the fleet mutinied because James had ordered Mass to be read on board the vessels; the Bishop of London was suspended; Dr. Pechell, vice-chancellor of Cambridge, was "deprived" for resisting a mandate from the king to admit Alban Francis, a Benedictine monk, to a degree without taking the oaths; the Fellows of Magdelen College were expelled for refusing to elect Anthony Farmer as their president; and Parliament was dissolved 2nd July, 1687. James II. received a Papal Nuncio at Hampton Court, 9th July; many of the lords-lieutenant of counties resigned because the king wished them to manipulate the parliamentary elections, and the lawyers of the Temple assented to the maxim, *a Deo rex, a rege lex*—from God the king, and from the king, law.

The Duke of Ormonde was dismissed from his double office of lord-lieutenant of Ireland and commander of the forces. He was replaced in the former office by the king's brother-in-law, Lord Clarendon, and in the latter by Richard Talbot, earl of Tyrconnel. Clarendon and his brother, Lord Rochester —who had been made lord-treasurer—were soon, however, as Protestants, dispensed with, and Tyrconnel became lord-deputy. He disarmed Protestants, disbanded Protestant soldiers, drew the militia entirely from the Romanists, from whose ranks also he filled the Privy Council and the bench. He used also the revenues of the Establishment for the payment of Romish priests. His aim was to declare Ireland a dependency of France, should James die without male issue. Protestant and Romanist were set at variance as much as possible by Tyrconnel.

James issued a second Declaration of Liberty of Conscience, 27th April, 1686, and ordered it to be read in the churches.

Arrival of William III.

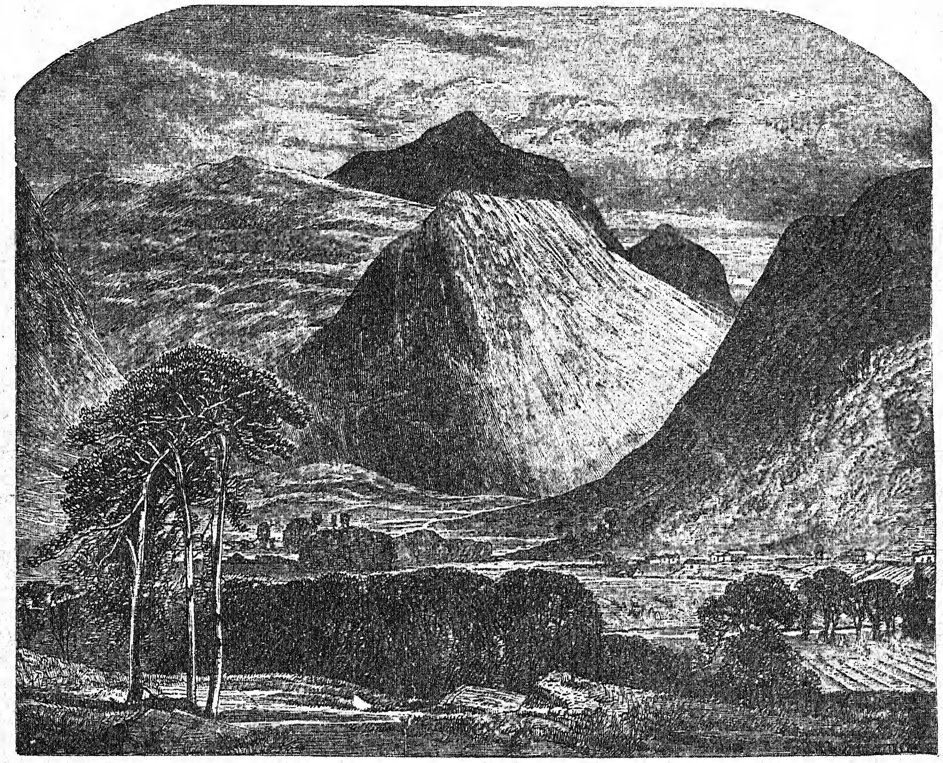
Against this Sancroft, the primate, and six bishops drew up a respectful remonstrance. They were imprisoned in the Tower 8th June, tried, and to the great joy of the nation, acquitted 27th June. On 11th June the queen gave (or was said to have given) birth to a prince—James, afterwards known as "the Old Pretender." This was treated as a Catholic attempt to foist upon the country a supposititious heir to the throne, and a Jesuitical intrigue against the (possible) accession of William of Orange, stadtholder of the Netherlands, grandson by his mother of Charles I., and the husband of Mary, eldest daughter of James I., who in default of an heir male would by matrimonial and personal right become successor to the English crown. Negotiations were thereupon opened with William by "the seven patriots"— the Earls of Devonshire, Shrewsbury, and Danby; Lord Lumley; Compton, bishop of London; Admiral Edward Russell, and Henry, brother of Algernon Sydney, 30th June. In September, William issued a declaration of the reasons for his conduct, announcing his intention to appear with an army and appeal to a free Parliament. He sailed from Helvoetsluys, 19th October, landed at Torbay, 5th November, reached Exeter on the 8th, was joined there by many nobles, clergy, and military men. James II., who had hurriedly endeavoured to propitiate his enemies and retrieve his character, went to Salisbury, found himself deserted by the Duke of Grafton, Lord Churchill, Prince George of Denmark and his wife the Princess Anne (James's second daughter), and learning that his army was untrustworthy, sent away his wife and the Prince of Wales. He shortly afterwards attempted to escape in disguise, threw the great seal into the Thames as he was crossing it, but was caught at Feversham, and brought back to London. He was removed thence to Rochester, guarded by Dutch troops. William proceeded to London and summoned the members of Charles II.'s Parliament together. They advised a Convention. James fled from Rochester, 20th December, and arrived in France on Christmas Day. When the Convention met they declared the throne vacant by abdication, offered the sovereignty to William and Mary, drew up a Declaration of Rights, on assenting to which the latter were proclaimed joint king and queen of England, 13th Feb., 1689, and the Revolution Settlement was accomplished without the striking of a blow.

The eventful change in the government of Great Britain, beginning in the early part of the reign of Charles I., and closing with the flight of James II., was intended to destroy royal arbitrariness and settle the laws on constitutional lines. Hence it is regarded as The Revolution. The conditions and safeguards which the representatives of the people "claimed, demanded, and insisted" upon in the Bill of Rights were:—1. That the following things are illegal: (1) the making or suspending of laws without the consent of duly chosen Parliaments; (2) the exercise of a dispensing power; (3) the maintaining of a standing army (without parliamentary consent); (4) the levying of taxes not duly granted by Parliament; (5) the granting of estates, as forfeited, prior to the conviction of the (accused) offender; (6) the holding of ecclesiastical commission (or other similar) courts; (7) the demanding of excessive bail. 2. That the following things are lawful: (1) the petitioning of the sovereign; (2) the keeping of arms; (3) the free exercise of the electoral franchise; (4) freedom of speech in Parliament; (5) trial by (a rightly impannelled and returned) jury; (6) frequent Parliaments. The claim of rights of person, property, and petition was admitted by the crown, and it was enacted as a pre-condition that if any king or queen of England should embrace Romanism or marry any Roman Catholic, the people should be absolved from allegiance to them.

Many of the more rigid Tories—including Sancroft, the primate, seven bishops, and about 400 clergy—refused to take the new oath of allegiance proposed, and were thence called Non-juror These were the nucleus of the Jacobite party. The

clergy resigned their preferments. An Act of Toleration—freeing Dissenters from penal statutes—and a Mutiny Bill (renewable annually) were passed. Scotland almost unanimously recognized the new sovereigns—though a few Romanists adhered to James. The Duke of Gordon held Edinburgh Castle for his old master, and Graham of Claverhouse (Viscount Dundee) raised the Highlanders against William III. They were met by General Mackay, 26th May, 1689, at Killiecrankie, where, though the Highlanders won, Graham fell, and the insurrection failed. The king's officers garrisoned all the Midland forts, and the clans were invited to make submission. This they did, but Macdonald of Glencoe failed to do so within the prescribed time. The Earl of Stair reported the case, and on being ordered to extirpate the offenders, placed the execution of the warrant in the hands of the Campbells. They marched to Glencoe in the guise of friends, were received as guests, and repaid the hospitality by butchering in cold blood, without distinction of sex or age, the people of the glen. The fatal mission which ended in the massacre of Glencoe, February, 1692, is an unforgetable incident in Scottish history.

By the help of Louis XIV. and the efforts of Tyrconnel, lord-deputy of Ireland, James, within three months of his flight from England, landed in Ireland and took the field with 40,000 men. Holding a Parliament in Dublin, an Act of Attainder was passed against 3000 Protestants. The Englishry rose in self-defence against the Irishry, and Londonderry, after enduring a severe siege of 105 days, succeeded in holding the enemy at bay till relief came, 30th July, 1689, and in August the Protestants, issuing from Enniskillen, routed the Irish army at Newtown-Butler. In 1690 Queen Mary was appointed regent while William was absent in Ireland. He landed at Carrickfergus, 11th June. Taking advantage of this Irish embroilment, France sent a fleet under Admiral Tourville to invade England. Admiral Lord Torrington, with a joint fleet of Dutch and English, went out



Entrance to the Pass of Glencoe.

against them, but suffered (some think willingly) an ignominous defeat off Beachy Head, 30th June. Next day, however, at the battle of Boyne Water—though Schomberg fell in the fight—William was victorious over the French and Irish army, and on the 22nd the Dutch general Ginkel, afterwards Earl of Athlone, defeated at Aughrim the French general St. Ruth, and compelled the gallant Patrick Sarsfield to surrender Limerick, 3rd October. Of the garrison, 1000 entered William's army, 2000 settled down in peace, and 11,000 entered Louis's army, subsequently becoming famous as the Irish brigade. James fled to Waterford and escaped to France. Severe laws were then passed against the Catholics, and Protestants held all places of power.

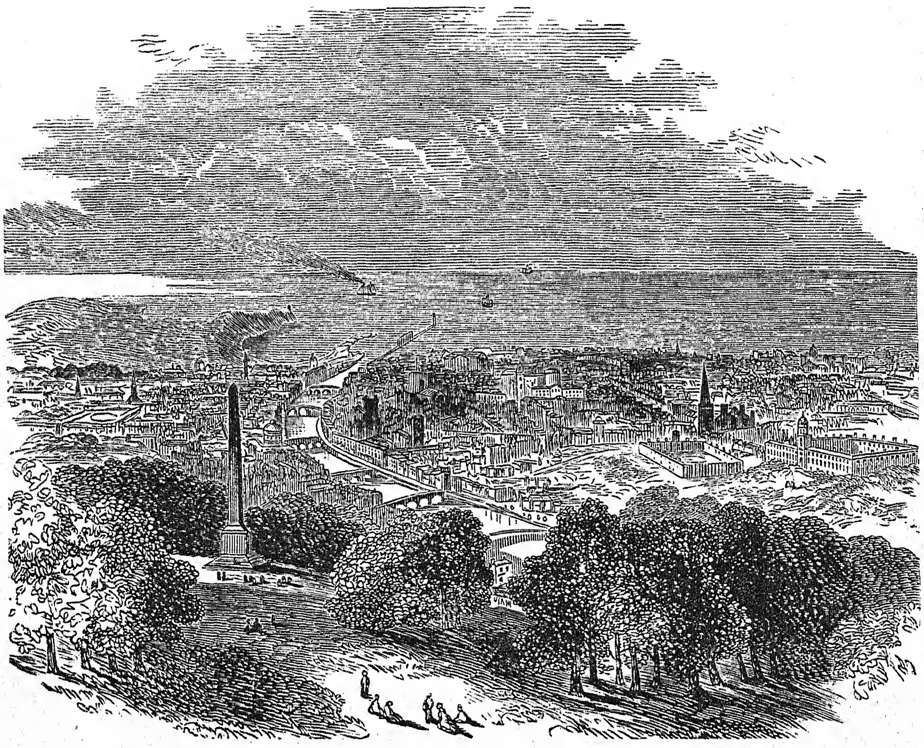
William's reign was complicated by intrigue and treachery at home, and by war abroad. In 1691 Viscount Preston was convicted of plotting against him; in 1692 Marlborough, being suspected of treason, was dismissed from all his offices. Louis XIV. was regarded as the terror of Europe. The chief European states—afraid that by his vast resources and ambitious projects the balance of power would be destroyed—had formed a coalition against him, and William III. had been recognized as the head of the confederation. He valued his accession to the English throne for the additional power and influence it gave him in the councils of the Continent. In 1691 William went to Holland to take part in the struggle against France. This was thought to give a favourable opportunity for a new attempt at invasion. Admiral Russell, though personally in favour of James, was intrusted by Mary with the command of the fleet. When Count de Tourville led forth his hostile squadron, Russell intercepted it, chased the enemy back to La Hogue, and after five days' severe contention, Rooke burnt their ships in the very presence of the troops of the enemy. Louis heard of this disaster while besieging Namur with 30,000 men, the engineering being under the charge of the distinguished Vauban. It capitulated, 30th June, 1692, before William could come to its relief. William next sought to surprise the French army under Luxembourg, but at the battle of Steinkirk, 24th July, he was defeated and compelled to retreat. Public attention was recalled from this failure by news of a Jacobite plot to assassinate William. Grandval a Frenchman, Dumont a Walloon, and Leofdale a Dutchman were the conspirators-in-

chief. Grandval was tried, convicted, and executed—having confessed his crime. Luxembourg and William next met at Landen, near Liège, 29th July, 1693, when the latter was defeated, and though Charleroi was taken, William was able to keep his army well in hand.

Hitherto William had striven to govern free from party bias, but now he found it necessary to select his advisers from those who were unmistakably pledged to the principles of the Revolution. Somers, Wharton, Russell, Montague, and (subsequently) Shrewsbury became his ministers, and Tenison succeeded Tillotson as primate. Montague proposed the incorporation of a joint-stock association which had been established, 1590, at the suggestion of a Scotsman named William Paterson, as "the Bank of England." On 27th July, 1694, this was accomplished. Its original capital, £1,200,000, was lent to the Government, at that time in great pecuniary straits. The only important warlike operation undertaken in 1694 was an expedition led by General Talmash against Brest, which was rendered unsuccessful by Marlborough's informing James of its purpose and its setting out. The English loss was heavy, and Talmash was slain (June). Mary was seized with smallpox, then epidemic in London, and died at Kensington, 28th December, 1694.

William was greatly grieved at Mary's death, and for some time felt unfitted for high tasks. At length he resolved to recommence his antagonism to Louis XIV. Rousing himself in full force, he invested Namur, 2nd July, 1695. Villeroi did his utmost to break through his lines, but failed, and Marshall Boufflers was compelled to surrender the fortress, 26th August. The tide had turned, William became the object of popular enthusiasm, and the Whigs were exuberant in their rejoicings.

Just a week before the queen's demise the Triennial Act—limiting the duration of parliament to that period, and declaring that no longer time than that should elapse without a Parliament—was passed. The second Parliament of William and Mary was dissolved 11th October, and the first of William III. met 22nd November, 1695. The majority was greatly in favour of the Government. It passed new laws for regulating trials for high treason and for reforming the coinage.



Dublin, from the Phœnix Park.

Somers, Montague, John Locke, and Sir Isaac Newton had oversight of the new coinage. Another Jacobite conspiracy to assassinate William—arranged by Sir G. Barclay, and managed by the Duke of Berwick—was discovered in February, 1696. The confederates, Charnock, King, and Keyes, were executed in March, Sir John Friend and Sir William Parkyns in April, while Sir J. Fenwick—who attempted to escape to France—was captured in June. By the new law of treason, two witnesses were required for conviction. One witness against him was made away with, and he could not be arraigned before the ordinary court. He was proceeded against by a bill of attainder, and on 28th January, 1697, he was executed—the last instance in England of such a condemnation. As a result of this conspiracy a Bond of Association was drawn up and largely signed. It declared that William was rightfully king, and that, if his death was compassed, the signatories would avenge themselves on the perpetrators. On 11th September, the expensive and protracted war with France was brought to a close by the Peace of Ryswick—providing for (1) the surrender by France of all conquests made since the treaty of Nimeguen, and (2) the recognition of William III. as king of England, and of Anne, second daughter of James II., as his lawful successor. As the foreign wars had not been successful, and this peace was concluded hastily and secretly, when the exhausted state of the finances of France made victory probable, William became unpopular, and despite his remonstrances Parliament reduced the army to 10,000 men, and demanded the discharge of all foreign soldiers—such as William's Dutch Guards, and those continental refugees who had fought under him at the Boyne. William indignantly threatened to leave England, but at last consented. Parliament was dissolved, 2nd July, and a new one met, 6th December, 1698.

William Paterson, founder of the Bank of England, projected the planting of a colony on the Isthmus of Panama, as an entrepôt between the eastern and western hemispheres. An entire monopoly of the trade of Asia, Africa, and America was granted by the Scottish Parliament to the Darien Company for thirty-one years. A capital of nearly half a million

was (nominally) raised, £220,000 being paid up. England, Holland, and Hamburg at first put down on paper half a million—though under the influence of the king and Parliament of England, these again withdrew from the scheme. A fleet of five ships sailed from Leith, carrying 1200 men, 25th July, 1698. In four months they reached their destination, settled in New Caledonia, planned New Edinburgh, and built the fort of New St. Andrews, and a second contingent of 1300 had already embarked for the colony. The English proclaimed the scheme an unsanctioned one. Great difficulties were experienced. Its suggestor became for a time insane. It failed, and only thirty of the emigrants returned to tell of the disastrous issue, and what might have been one of the "enterprises of great pith and moment" in the commercial development of Britain completely collapsed. Scotland was grieved and enraged. The condition of Spain at this time partly explains the policy of England in discountenancing a scheme which might have led to Spanish reprisals and a renewal of war.

Charles II. of Spain was feeble and had no issue. Three claimants for the succession appeared—(1) Louis, the dauphin of France, whose mother was the eldest sister of Charles—though she had renounced for herself and her heirs all claim to the sovereignty of Spain; (2) Leopold, the German emperor, as heir of his mother Maria, daughter of Philip III.; and (3) Joseph Ferdinand, in right of his (deceased) mother, daughter of Leopold and his wife Margaret, sister of Charles II. To the latter, in fact, Charles II. by will (1698) left his dominions. William secretly entered into a treaty that the Spanish dominions should be partitioned, 11th October, 1698, and on the death of Joseph Ferdinand, 1699, a second treaty was signed, March, 1700. These treaties Louis revealed to Charles, and he made a will, 2nd October, 1700, in favour of Philip of Anjou, who afterwards became Philip V. of Spain. England was dissatisfied at the important advantages conceded to France by these treaties, and was not pacified till William joined the Grand Alliance between England, Austria, and Holland, 1701, which ultimately led to a renewal of war with France.

The Duke of Gloucester, the only surviving child of Anne (Hyde) of Denmark, died 1700, and a new Act of Settlement was required. This limited the succession to the princess Sophia, fifth daughter of Elizabeth (the Electress Palatine), and her issue, being Protestants, on condition that (1) Britain should only be called upon to fight in defence of its own dominions; (2) the sovereign should not quit the realm without leave; (3) important resolutions on state affairs should be signed by those who advise and approve of them; (4) foreigners shall not hold places of trust under the Crown; (5) persons holding office or pension under the crown shall not be eligible to sit in Parliament; (6) that judges shall be removable only on process by both houses of Parliament.

James II. died at St. Germain, 6th September, 1701, and Louis XIV. recognized his son as James III. King of England, and the Grand Alliance was engaged in. William had had a life-long struggle against the growing power of France. He had laboured earnestly to stir up resistance to the ambitious designs of Louis XIV., who had declared "the Pyrenees no longer exist." William resolved to erect a mightier barrier between the thrones of France and Spain than even the Pyrenees—the voice of civilized Europe. Louis had (1) reserved by letters patent his grandson's right to the French crown; (2) suggested that Spain should cede the Netherlands to him; and (3) recognized James III. and promised him support. The Parliament, which had grudged war supplies, was dissolved 24th June, and on 30th December, 1701, a new Parliament met, eager to assist the king in maintaining that the crowns of France and Spain should not be united, and that neither the West Indies nor the Netherlands should be acquired by the sovereign of France. This great political movement had just been agreed to, and a formal declaration of war resolved on, when William, who had always been weakly in health, was, while riding in Hampton Court Park, thrown from his horse Sorrel, which had stumbled upon a mole-hill. His collar-bone was broken (21st February), fever ensued, and it proved fatal on the 8th of March, 1702. William died at Kensington, and was buried in Westminster. He was the greatest European statesman of his day, and he taught England, by his example, how to maintain the liberty of Europe and retain its own freedom. He saved England from the tyranny of the Stuarts, from the ambition of France, and from the domineerings of faction and party pursued not for national but personal aggrandizement.

William III. was blunt in manner, reticent of speech, a sound politician, and a careful ruler; but, as Lord Macaulay says, "he appeared ignorant or negligent of those arts which double the value of a favour and take away the sting of a refusal." As the head of the league of the Protestant princes of Europe he was astute and trustworthy. Though often thwarted by Parliament, he adhered tenaciously to his purposes and policy. To him we owe some early instalments of the freedom of the press, the inauguration of ministerial responsibility as the safeguard of government by party, the introduction of a national finance supervised by Parliament, the recognition of religious tolerance in Britain, and the careful superintendence of Protestant interests in Europe.

Anne and her husband, Prince George, brother of Christian V., king of Denmark, adhered in 1688 to the principles of the Revolution. She was born at Twickenham, 6th February, 1664, brought up in the Church of England, and married in 1683. Of her nineteen children all died in infancy except the Duke of Gloucester, who attained the age of twelve, but died in 1699. This made a revision of the Act of Settlement necessary. In accordance with its provisions Anne ascended the throne on the death of William III., and was crowned queen at Westminster, on St. George's Day, 23rd April, 1792. The Prince Consort, George, sat in the House of Lords as Duke of Cumberland, and held office as generalissimo and high admiral. He had neither the title nor the authority of king. Owing to the animosity rankling in the hearts of the Scots for the wrongs endured at Darien, some difficulties in regard to the succession occurred, and the Scottish Estates passed an Act of Security (1704), declaring that unless the independence of Scotland was secured and her commercial rights respected, they—while making their choice of a sovereign from the Protestant succession in the royal line—would select a different monarch from that selected by England. The embitterment rose to so great a height that Scotland began to prepare herself for war, and England threatened condign vengeance. In these circumstances a commission of thirty-one members from each nation was appointed to discuss the terms of a treaty of union, with Daniel Defoe as its secretary, April, 1706. After three months' debate, the terms were settled and presented to the Scottish Parliament, 3rd October, 1706. Great excitement prevailed, but at length by diplomacy (and some say bribery) a majority of 110 to 69 was won over, and the Act of Union, touched with the royal sceptre by the Duke of Queensberry, Lord High Commissioner, became law in Scotland on the 16th January, and in England on the 1st May, 1707.

To an Act, passed in 1711, for the restoration of lay-patronage in the Church of Scotland, almost all the ecclesiastical troubles of that country may be traced—the Secession of 1733; Burgher and Anti-Burgher Contention, 1747; the Relief Movement, 1756; the ten years' conflict ending in the Disruption, 1843; and the institution of the Free Church. By the Patronage Abolition Act of 1874 this grievance was redressed.

Anne wisely adopted William's position in the Grand Alliance. War was accordingly resolved on and declared against France and Spain, 4th May, 1702. The Emperor Leopold and most of the princes of the empire, the Dutch, and the English—who were joined shortly afterwards by the King of Portugal and the Duke of Savoy—forming the members of the Alliance, placed the command of the troops in the hands of the Earl of Marlborough, who had regained William's favour, and was captain-general of the forces at home and abroad. Owing to the inactivity of the Dutch but little was done in 1702. In 1703, however, Venloo, Ruremond, and Stevensward were captured by him within the space of two months, and Liège was stormed and taken 23rd October. In an action between a French squadron and the English fleet in the West Indies, Admiral Benbow, disgracefully deserted by his captains, suffered defeat, 19–24

August. Sir George Rooke made an unsuccessful endeavour to secure Cadiz in September, but subsequently attacked the Plate fleet, which had put in at Vigo Bay, and captured ten ships of war as well as several galleons in October. In 1704 Marlborough crossed the Rhine, held conference with Prince Eugène on the means to be pursued to prevent the junction of three great armies intended by Louis to overwhelm the allies. They forced the passage of the Danube in the face of the guns of Schellenberg, 2nd July, met Marshals Tallard and Marsin and the Elector of Bavaria near Blenheim, 13th August, and gained "a famous victory." Meanwhile Sir George Rooke, on the same day, fought a (drawn) sea-fight with the Count of Toulouse, off Malaga, in Spain. In 1705 Charles Mordaunt, earl of Peterborough, invested Barcelona, which surrendered in September. The battle of Ramilies, near Brabant in Belgium, was won 23rd May, 1706, by the great duke. Eleven months afterwards Henry Ruvigny, earl of Galway, a Huguenot, was defeated at Almanza by the Duke of Berwick. In rapid succession came the victories of Oudenarde, St. Philips, and Lille, 1708; of Tournay, Malplaquet, 11th August, and Mons, 11th September, 1709; as well as the Spanish successes, under General Stanhope, of Almenera, 27th July, Saragossa, 20th August, Brihuega and Villaviciosa, 10th December, 1710. The closing fight of the War of Succession was that of Denain, 24th July, 1712, when Arnold von Keppel, earl of Albemarle, was defeated and taken prisoner by Marshal Villars.

Popular enthusiasm sustained Marlborough during the early years of the war, but political intrigue—originating after Prince George's death, 28th October, 1708, and the supercession of the Duchess of Marlborough in the queen's favour by Mrs. Masham—led to the dismissal of Godolphin and Sunderland, and the appointment of Bolingbroke and Oxford, the displacement of Marlborough, and the advancement of the Duke of Ormond to supreme command. The Austrian claimant, Charles, had gained the Imperial throne, and as the war had become unpopular the new ministry resolved to seek peace. The allies protested, but they carried through their design, and the peace of Utrecht, 11th April, 1713, brought hostilities abroad to a conclusion, only to reopen political contests at home. Oxford and Bolingbroke quarrelled regarding the succession; the former favoured the Hanoverians and the latter the son of James II., the Chevalier de St. George. Bolingbroke prevailed, and a Jacobite ministry was in process of formation when Anne became ill. The Whigs in this strait, at the suggestion of the Duke of Shrewsbury, determined on a bold stroke for the retrieval of their power. The Dukes of Somerset and Argyle, as the result of a meeting of the Privy Council, entered the council chamber unsummoned, and a deputation was sent to request Her Majesty to confer on Shrewsbury the office of Lord High Treasurer. This Anne did, telling him to use his staff "for the good of the people." The Whigs regained place, and took steps to prevent the formation of a party favourable to the Pretender. The Princess Sophia died, 28th May, 1714, leaving a son George, Elector of Hanover, her heir, according to the Act of Settlement. In July Anne became ill, and on 1st August, 1714, died.

In personal disposition Anne was mild and amiable, but she had no marked character—was more estimable as a woman than admirable as a queen. She was greatly influenced by friendships and favourites, and exceedingly bigoted in religious matters. Hence, in her reign, the Occasional Conformity Act was persistently urged to nullify the Act of Toleration, till it became law in 1711. This was followed by a Schism Act, which was to come into force on the very day of the queen's death, but thereby became a dead letter. Queen Anne's "bounty" yet shows her sympathy with the holders of the smaller church livings. The property qualification for members of Parliament, enacted in her reign, was only repealed under Queen Victoria. Her reign is often spoken of as the Augustan era of British literature. But though some of the most brilliant names in literature, art, and science were inscribed on the roll of fame during that period, she gave little active encouragement to those who illustrated Britain's annals by their efforts in these important walks.

THE GREEK LANGUAGE.—CHAPTER XIV.

PREPOSITIONS—THEIR SIGNIFICATION AND SYNTAX.

To the student, at first sight, few things can appear more perplexing than the great variety of significations assigned by grammarians to Greek prepositions, and doubtless this apparent want of distinct and specific meaning constitutes one of the chief impediments to the acquirement of a proper working knowledge of these important elements in speech. The instructions given in this chapter will, it is hoped, contribute somewhat to remove the difficulties of the learner and to secure a full and thorough knowledge of the use of Greek prepositions, with their appropriate meanings and their correct regimen.

The prepositions do not in themselves primarily express motion, but they imply or indicate the relations of bodies which are (1) in motion, (2) at rest, or (3) the direction of bodies capable of moving. The transition from the expression of place to the indication of time and the relations of abstract ideas is easy.

Prepositions combine with their own primary signification that of the case with which they are joined; and this combination is the chief cause of the various senses which, in translation, seem to be ascribed to them. The attention of the student, while engaged on this subject, must be given not only to the primary specific signification of the preposition, but also to the sense of the cases with which it is (or is to be) conjoined —viz., the genitive, *origin;* the dative, *instrument;* and the accusative, the *end* or object to which a thing tends or in which it terminates. A writer assigns to each preposition the government of that case on the meaning of which it is his design to fix the attention of his reader. The primary meaning of prepositions is to be sought in some root from which they are originally derived, and from which their specific meaning is obtained. Either this meaning—or one obviously connected with and flowing from it, by analogy—each preposition preserves in all its usages, however different the translation given to it by grammarians may be. As the etymological investigation into the roots from which the several Greek prepositions were originally derived, and any philosophical deduction from these as to the primary signification which each proposition implies, would require a larger acquaintance with comparative philology and a wider knowledge of the philosophy of grammar than we could assume our students can possess, and as, moreover, such an endeavour would necessitate intricate and lengthy references to the laws of thought, euphony, and speech, we cannot undertake it here. We have carefully selected the significations here given and illustrated, arranging them in the order of their nearness to and remoteness from the most usual specific meaning, and translating them by the nearest English equivalents available. It is all the more important that, in a work like this, such aid should be given, as these prepositions are employed as prefixes in a very large number of English words, and an accurate knowledge of their signification will greatly help the student to comprehend the full force of many of these very important vocables.

Prepositions which imply one relation only, whether of motion or rest, govern only one case. Those which may indicate one or other of these relations can govern two cases —one for each of the relations implied. The general rule is that motion *to* governs the accusative; motion *from*, the genitive; and rest in, the dative. But these distinctions are not rigorously observed. One can readily understand that—because the specific distinctions of thought are far more numerous and minute than ordinary words can indicate—one word must frequently express differing implications. As, besides this, no two races or nations using different languages run exactly parallel one with another in mode of thought and form of phrase, the inner shades of meaning and delicacies of implication cannot be adequately expressed by one single and invariable term. These considerations may aid the student in his endeavour to fix in his mind the meaning and management of the Greek prepositions.

There are eighteen prepositions, of which four, *ἀντι*, *ἀπο*, *ἐκ* or *ἐξ*, and *προ*, govern the genitive; two, *ἐν* and *συν*, the dative;

two, εἰς and ἀνα. the accusative; four, δια, κατα, μετα, and υπερ, the genitive and accusative; and six, ἀμφι, ἐπι, περι, παρα, προς, ὑπο, the genitive, dative, and accusative.

I. The following four govern the genitive—viz. ʼΑντι, (1) in front of: ἀντ' οφθαλμοιν, in front of (before) the [two] eyes; (2) opposed to, or against: ἀντ' Αἰαντος κυδαλιμοιο, against the illustrious Ajax; (3) in preference to: ἀντι κακων ἁπαντον, in preference to all the wicked; (4) in exchange or return for: χαρις ἀντι χαριτος, favour in return for favour; (5) in place of: εἰρηνη ἀντι πολεμου, peace in place of (instead of) war.

ʼΑπο, (1) from: ἀπο Σαρδεων, from Sardes; (2) away from beside: ἀπο σκοπου, away from the mark; (3) by, by means of: ἀπ' ἀργυρεοιο βιοιο, by means of the silver bow; (4) of: οἱ ἀπο της στοας, those of the porch, the Stoics; (5) after: ἀπο δειπνου, after supper.

ʼΕκ or ἐξ, (1) out from: ἐξ Αττικης, out from Attica; (2) from: ἐκ Διος, from Jupiter; (3) out of: ἐκ πηλου, out of clay; (4) of: οἱ ἐκ της στοας, those of the porch, the Stoics; (5) by: ἐκ φυσεως, by nature; (6) after: ἐκ πολλης ἡσυχιης, after long silence.

Προ, (1) before: προ θυρου, before the door; (2) in preference of: πολεμος προ εἰρηνης, war in preference to peace; (3) in behalf or in defence of: προ των ἰδιων, in defence of his property.

II. The dative is governed by the two following—ʼΕν, in: ἐν Βαβυλωνι, in Babylon; ἐν τρισιν ἡμεραις, in (the space of) three days.

Συν (ξυν), (1) with: συν σοι, with thee; (2) together with: συν τευχεσιν, together with his armour.

III. The accusative is governed by the two following—Εἰς or ἐς, (1) to or into: εἰς Σαρδις, to Sardes; εἰς οὐδενος διδασκαλου, to no master's [οἰκον, house]; (2) against: εἰς τους ʼΑθηναιους, against the Athenians; (3) with respect to: πλην εἰς θυγατερας, except with respect to my daughters; (4) (with numerals) about: εἰς δεκα μυριαδας, about (the number of) ten myriads. ʼΩς, to, applied to persons only, is used instead of εἰς or προς, as ὡς τον βασιλεα, to the king.

ʼΑνα, (1) up: ἀνα τον ποταμον, up the river; (2) up through: ἀνα τα ὀρη, up through the mountains; (3) upon: ἀνα μυρικην, upon a tamarisk; (4) up to: ἀνα εἰκοσι μετρα, up to twenty measures; (5) among: ἀνα πρωτους, among the first.

[The Epic and Doric poets sometimes use ἀνα with the dative, meaning upon: χρυσεω ἀνα σκηπτρω, upon a golden sceptre.]

IV. The four following govern the genitive and accusative: Δια with (*a*) genitive signifies (1) through: δια της χωρας, through the country; (2) after or in: δια χρονου, after (in process of) time; (3) by means of: δια των ὀφθαλμων, by means of the eyes; (4) before or above: δεης ἀξιον δια παντων, worthy of observation above all. (*b*) The accusative, by reason or on account of, δια την ἐκεινου μελλεσιν, by reason of his delay.

Κατα with (*a*) the genitive, (1) down: κατ' Οὐλυμποιο καρηνων, down the heights of Olympus; (2) beneath: κατα γης, beneath the earth; (3) in the direction of: κατα σκοπου, in the direction of (at) a mark; (4) against: κατα του Θεου, against the Deity; (5) in: κατα πασων των τεχνων, in all the arts. (*b*) The accusative, (1) in or all through: κατα στρατον, in, or all through, the army; (2) on: κατα στηθος, on the breast; (3) along: κατα την ὁδον, along the way; (4) according to: κατα τας ἐντολας, according to the orders; (5) on account of: κατα πενιαν, on account of poverty; (6) pertaining to: αἱ κατα το σωμα ἡδοναι, pleasures pertaining to the body; (7) near: καθ' ἡμας, near us [where we are]; (8) during or at the time of: κατα τον προτερον πολεμον, during the former war; (9) adverbially with its case: κατ' αἰσαν, agreeably to reason, justly.

Μετα with (*a*) the genitive, (1) with: μετα δολου και τεχνης, with fraud and art; (2) together with: μετα πολλων ξυμμαχων, together with many allies. (*b*) With the accusative, (1) after: μετα χρονον, after a time; (2) to or towards: μετα νηας, to, or towards, the ships.

In the poets μετα is joined with the dative when it signifies (1) among: μετα δε τριτατοισιν ἀνασσεν, he was ruling among the third; (2) with: μετα πνοιαις ἀνεμοιο, with the blasts of the wind.

ʼΥπερ with (*a*) the genitive, (1) above: ὑπερ των στεγων, above the roofs; (2) in defence of or in behalf of: ὑπερ της πολεως, in behalf of the city; (3) in place of: ὑπερ ἐμου, in place of me; (4) concerning: ὑπερ της εἰρηνης, concerning the peace. (*b*) The accusative, (1) over or beyond (motion): ὑπερ τον δομον, over (beyond) the house; ὑπερ τα τεσσερακοντα ἐτη, beyond forty years; (2) contrary to (in opposition to κατα): ὑπερ αἰσαν, contrary to reason, unjustly.

V. The following six govern the genitive, dative, and accusative—viz. ʼΑμφι (*a*) with the genitive, (1) about: ἀμφι πολεως, about the city; (2) concerning: ἀμφι φιλης θυγατρος, concerning a dear daughter. (*b*) The dative, (1) close about: ἀμφι στηθεσσιν, close about the breast; (2) on: ἀμφι πυρι, on the fire; (3) concerning: ἀμφι ἀποδω τη ἐμη, concerning my departure; (4) for or on account of: τοιῃδ' ἀμφι γυναικι, on account of (for) such a woman. (*c*) The accusative, (1) about: οἱ ἀμφι Πριαμον, those about Priam [*i.e.* Priam and his suite]; (2) concerning: τα ἀμφι τον πολεμον, things concerning the war.

Περι with (*a*) the genitive, (1) about: περι σπειους, about the cave; (2) concerning: περι ψυχης, concerning the soul; (3) for: περι πατριδος, for one's country; (4) above (Hom.): περι παντων, above all. (*b*) The dative, (1) close about: περι σωματι, close about the body; (2) concerning: περι ποιμενι λαων, concerning the shepherd of the people. (*c*) The accusative, (1) about: περι την πολιν, about the city; (2) concerning; περι τι, concerning anything.

ʼΕπι with (*a*) the genitive, (1) upon: ἐπι των ὠμων, upon the shoulders; (2) towards: ἐπι Σαρδεων, towards Sardes; (3) in: ἐπ' εἰρηνης, in peace, in time of peace; (4) at: ἐπι των θυρων, at the door; (5) by: ἐπι σφων αυτων, by themselves. (*b*) The dative, (1) close upon: ἐπι στοματι του ποταμου, close upon the mouth of the river; (2) in the power of: ἐφ' ἡμιν, in the power of us [in our power]; (3) on condition of: ἐπι τουτοις μονοις ζην, to live on condition of these things alone; (4) on account of: ἐπι τω κερδει, on account of gain; (5) besides: ἐπ' ἐκεινη, besides (in addition to) that. (*c*) The accusative, (1) upon: ἐπι κεφαλην, upon the head; (2) against: ἐπι τας ἡδονας, against the pleasures; (3) for or during: ἐπι δυο ἡμερας, for (during) two days.

Προς with (*a*) the genitive, (1) of: προς ἀνδρος σοφου ἐστι, it is (the part) of a wise man; (2) by or from: προς Λακεδαιμονιων, by or from the Lacedæmonians; προς των Θεων, by the gods (in attestation); (3) on the side of, or with: προς ἡμων, on the side of (with) us; (4) in the quarter of, or towards: προς ἡλιου δυσμεων, towards the setting of the sun; (5) for the good of: προς της πολεως, for the good of the city; (6) in presence or on the part of: προς Θεων μακαρων, in presence of the blessed gods. (*b*) The dative, (1) close to: προς τη πολει, close to the city; (2) besides: προς τουτοις, besides (in addition to) these. (*c*) The accusative, (1) to or towards: προς μακρον ʼΟλυμπον, to, or towards, lofty Olympus; (2) against: προς τον βαρβαρον, against the barbarian; προς ἡμεραν, against daybreak; (3) on account of: προς τουτο, on account of this; (4) with respect to: τελεος προς ἀρετην, perfect with respect to virtue.

Παρα with (*a*) the genitive, from: οἱ παρα των Περσων ἀγγελοι, the messengers from the Persians. (*b*) The dative, (1) close beside: παρα βασιλει καθηται, he sits close beside the king; (2) among: παρα ποιμεσι πρωτος, first among the shepherds. (*c*) The accusative, (1) to beside: παρα νηας ʼΑχαιων, to beside the ships of the Greeks; (2) beside or along: παρα θινα θαλασσης, beside or along the shore of the sea; (3) beyond: παρα τα ἀλλα ζωα, beyond the other animals; (4) on account of: παρα την αὐτου ῥωμην, on account of his own strength; (5) contrary to: παρα δοξαν, contrary to belief.

ʼΥπο with (*a*) the genitive, (1) under: ὑπο γης, under the earth; (2) on account of: ὑπο ἀπειριας, on account of inexperience; (3) by: ὑπο των πολεμιων, by the enemies. (*b*) The dative, (1) close under: ὑπο πτεροις, close under the wings; (2) under the influence of: ὑπο Λακεδαιμονιοι, under the influence of the Lacedæmonians; (3) by: ἐμαις ὑπο χερσι, by my hands. (*c*) The accusative, (1) to beneath: ὑπο την

στεγην, to beneath the roof; (2) under: ὑπο γην, under the earth; (3) at: ὑπο Τροιαν, at (near) Troy; (4) near: ὑπο τους αὐτους χρονους, near (about) the same times.

The following instances of the use of Greek prepositions will serve not only as examples but aids to the memory as regards meaning:—ἀνα, anachronism, analogy, anatomy; ἀντι, antagonist, antidote, antitype; ἀπο, aphelion, apostacy, apostrophe; κατα, catalogue, catarrh, catastrophe; δια, diagonal, dialogue, diameter; ἐν, encomium, enthusiasm, endemic, emblem, emporium; ἐπι, epigram, epilogue, epitaph; ὑπερ, hyperborean, hyperbole, hypercritical; ὑπο, hypochondriac, hypocrite, hypothesis; μετα, metaphor, metaphysics, method; παρα, paradigm, paragraph, paroxysm; περι, perimeter, period, periphery; συν, syncope, synod, system, syllogism, sympathy.

Prepositions often govern the same case in composition as they do separately; *e.g.* ἀπεχομαι κακων, I refrain from mischief.

Prepositions are often omitted, and require to be supplied to render the grammatical construction complete; *e.g.* με ερυκε (απο) μαχης, conduct me from the battle; (προς or εις) πολιν ἱκεσθαι, to go into the city; ερχονται (δια) πεδιοιο, they came along the plain.

Though the construction be complete without a preposition, one is often inserted to give greater distinction, emphasis, or prominence to the sense. Εις ὑμων, one of you, is good Greek; but the distinction is made more explicit by saying, ἑις εξ ὑμων. Αρξομαι της ειρωνειας, I will begin with dissimulation, conveys a complete meaning; but it is more emphatic when απο is inserted, αρξομαι απο της ειρωνειας.

Prepositions when compounded with nouns, adjectives, and verbs impart to the terms thus compounded the sense which they bear in a separate state, or one analogous to it.

CHAPTER XV.

THE LAWS OF ACCENT.

EVERY word of more than one syllable has an articulative stress laid upon one of its syllables. This syllabic stress is called the accent. In Greek, the accent is often found on a short syllable, and is used to give *tone* rather than to mark *quality*. This is a usage in which we cannot follow the ancients. Knowledge of Greek involves an acquaintance with the laws of accentuation, as not unfrequently words which are identical in spelling, but different in meaning, are only distinguishable by their accent.

There are, as was explained on page 192, three accent-marks in Greek—viz. (1) the *acute*, e.g. τιμή; (2) the *grave*, e.g. τινὸς; (3) the *circumflex*, e.g. αὐλῆς.

The *acute* may stand on any of the last three syllables of a word, and the *circumflex* on either of the last two.

Every syllable not accented by one or other of the two foregoing accents is considered as *grave*, but the grave accent is only *written* over the last syllable of a word when no punctuation mark follows it. The grave indicates that the acute is not for the time to be used; *e.g.* ἀνά, τούς, and ἀγρούς have an acute accent on the final syllable; but this is turned into a grave when the words meet in a sentence without any punctuation mark between; as, ἀνὰ τοὺς ἀγροὺς των γεωργων.

The circumflex is a combination of the acute and the grave; thus, -έὰ when contracted makes ῆ or ῆ, or (in cursive writing) ῆ. It can be used only on syllables *naturally* long, *i.e.* containing a long vowel or diphthong; as, αὐλῆς, φεῦγε.

When the last syllable of a word is short, the acute accent *may* stand on the antepenult; as ἄνθρωπος.

The terminations -οι and -αι (except when they occur in the optative mood), and the (Attic) inflexions -ως and -ων, are, in regard to accent, treated as short syllables; *e.g.* ἄκανθαι, πολῖται, ἄνθρωποι, πόλεως, ἀνώλεων.

When the last syllable of a word is long, the acute accent cannot stand further back than the penult; *e.g.* ἀνθρώπου.

The circumflex can be used on the penult only when the last syllable is short; *e.g.* μυῖα, μῆτερ, γλῶττα, but nominative dual μυίā, γλώττης, and μήτηρ.

In contractions, (1) if the first member of the concurring vowels have the acute, the contracted syllable will have the circumflex; *e.g.* φιλ-έο-μεν, φιλ-οῦ-μεν, βασιλ-έϊ, βασιλ-εῖ, &c. (2) If the second have the acute, the contracted syllable will, except a few words like ἀργύρεος, ἀργυροῦς, retain it; *e.g.* φιλ-εού-σης, φιλ-ού-σης. (3) If neither have the acute accent, the contracted syllable will be unaffected; *e.g.* μαντ-εε-ς, μαντ-ει-ς; τιμ-αο-μενη, τιμ-ω-μενη.

In regard to the accent in inflected words we can only say that the position of the accent in the nominative singular of any declinable word must be either (1) learned by practice, or (2) ascertained from the lexicon; but when this is known, the accent of the oblique cases is easily settled by the following general rules:—

(1) The accent remains throughout the oblique cases on the same syllable as in the nominative, so long as the quantity of the final syllable permits; as, αὐλ-ή, αὐλήν; βασιλ-εύς, βασιλ-έα; παρθέν-ος, παρθέν-οι; λειμών, λειμῶν-ος; ποιμήν, ποιμέν-ος; αἴγειρος, αἴγειρον, but αἰγείρου. But genitives and datives of the Third Declension, increasing their syllables in these cases, take the accent on the inflected part; as, θήρ, θηρ-ός, θηρ-οῖν, θηρ-ῶν, θηρ-σί; but accusative θῆρ-α, nominative plural θῆρ-ες. Syncopated nouns take the accent as if they had not been contracted; as, μήτηρ, genitive μητρ-ός (not μῆτρος); θυγάτηρ, genitive θυγατρός (so γυνή, genitive γυναικός, γυναικῶν, though not syncopated).

(2) The inflexions of all genitives and datives, when long, take the circumflex if the tone be on the inflected syllable; as, σκι-ά, σκι-ᾶς, σκιᾶ, σκι-αῖν, σκι-αῖς; ἀετ-οῦ, ἀετ-ῶν; θηρ-οῖν, θηρ-ῶν; θε-ῷ, θε-οῖς; but the other cases take the acute; as, σκι-αί, σκι-άς; θε-ούς; ἀετ-όν.

(3) The genitive plural of the First Declension has always a circumflex on the last syllables—because -ων is contracted for -άων; as, σκι-ῶν for σκι-άων.

(4) Vocatives in -ευ and -οι take the circumflex on the last syllable; as, βασιλ-εῦ, Λητ-οῖ.

In verbs the accent is placed as far back as the quantity of the final syllable will allow; *e.g.* τύπτομεν, τύπτεται, τυπτοίσθην, βουλεύσαι (optative); but those parts of verbs in which there was originally a contraction (real or supposed) follow the rule for contracted syllables; *e.g.* ἀγγελῶ, *fut.*, for ἀγγελέω; μενεῖτον, *fut.*, for μενέετον; ἱστῶμεν, for ἱστάωμεν; λυθῆς (1 aorist passive).

The accent of the following parts, however, requires to be specially noted—viz. (1) in the active voice (*a*) aorist infinitive takes the accent on the penult, λῦσ-αι; (*b*) aorist infinitive on the final, γιπ-εῖν; (*c*) aorist participle on the final, λιπ-ών; (*d*) perfect infinitive on the penult, λελυκ-έναι; as do also all infinitives in -ναι; as, τιθέναι. (2) In the middle voice, aorist imperative is accented on the final syllable, as, λιπ-οῦ; but aorist infinitive on the penult, λιπ-έσθαι. (3) In the passive voice, perfect infinitive takes the accent on the penult, λελύ-σθαι; and so does the perfect participle; *e.g.* λελυ-μένος.

All participles of the Third Declension, ending in ς, take an acute on the final syllable; as, λυθείς (1 aorist passive), and τιθεις (present active); but the participle of 1 aorist active follows the general rule; as, βουλεύσας.

Some small words, such as οὐ, εἰ, ὡς, ἐν, εἰς (ἐς), ἐκ, ὁ, ἡ, οἱ, αἱ, are called *proclitics*, because they throw forward their accent on the word following, if they are connected with it in syntax; *e.g.* ἐν μάχῃ, εἰς μάχην.

Enclitics again are small, unemphatic words, which throw back their accent on the preceding word (if connected in meaning), so that the two words form, as it were, only one in pronunciation; *e.g.* κόρη τις, νομεῖς τινες, βασιλεύς ἐστι, δοῦλος τις, βοῦν τινα.

ENGLISH LITERATURE.—CHAPTER XV.

SECTION I.—THEOLOGY OF THE SEVENTEENTH AND EIGHTEENTH CENTURIES.

THE Church has a professional relationship to Literature. In the exponents of religious doctrines we naturally expect chaste thought expressed in a calm clear style, animated but not overcharged with emotion. Theology is not always, in its literary form, suffused with all the graces of the Spirit, or adorned by all the graces of expressive art. Sermons ought to instruct, persuade, and impress, and though they should in the main be perspicuous and simple, may not only be polished and elevated, but exhibit pleasing sentiments touched with poetic brilliancy, and critical observations regulated by the keenest logical distinctness. When discourses are cast in a scholastic mould, or appeal to the people beyond the pulpit through the press, their claim to a place in letters should be substantiated and approved by such artistic merit as marks off literary from ordinary expression. We are not here required to record books on theology merely as such, even though they were most effective in regard to the momentous controversies which divided the church and nation. Hooper and Cranmer hold historic places; so do Whitgift and Dr. Reynolds half a century later; and Baxter, Calamy, Sheldon, and Gauden at the Savoy Conference, 1661. Much that was ephemeral and personal is included in the writings of those who carried on the struggle for strongly felt faith within or without the church. That thought of either party which has survived the trial of time as an exposition of vital intellect and literary influence, however, requires note.

William Perkins (1558–1602), a most earnest and voluminous "conforming nonconformist," while lecturer of Great St. Andrew's, Cambridge, filled that city "with the fragrance of the gospel." Arminius replied to some of his writings, which thus occasioned the meeting of the Synod of Dort. Perkins was succeeded by Paul Baynes (died 1617), an able Puritan commentator, and his zeal inflamed Dr. Richard Sibbes, Master of Catharine's Hall, author of "The Soul's Conflict" and "The Bruised Reed." He exercised an influence on Milton, Fuller, Thomas Goodwin, Oliver Cromwell's friend Joseph Mede (1586–1638), whose "Clavis Apocalyptica" has value as a key to prophecy even yet; Thomas Gouge (1605–81), whose missionary labours in Wales after his ejection in 1662 were apostolical; John Arrowsmith (1602–59), who, despite a weak and sickly body, was lively and clear, holy and learned in life and in writings; and many others. Among them was Jeremy Taylor (1613–67), a barber's son, though descended from Rowland Taylor the martyr. He entered Caius College, Cambridge (the city of his birth), as a poor scholar, 1626, and ten years later was admitted a fellow of All Souls, Oxford. He joined the king in 1642, and issued "Episcopacy Asserted," in which he follows Hooker and Hall in the line of argument employed. When Royalism was on the wane he kept a school at Golden Grove, near Carmarthen, under the protection of Richard Vaughan, earl of Carberry; this place he used as a title to a catechism for children, on account of some remarks in which he was imprisoned. "In adversity and want, without books or leisure," he wrote "The Liberty of Prophesying," showing "the iniquity of persecuting differing opinions;" a "Life of Christ," clear, earnest, and well arranged; "Holy Living and Holy Dying," devotional, fervent, and eloquent. Cromwell gave him a passport to Ireland. Under Charles II. he was made bishop of Down and Connor, and vice-chancellor of Dublin University. His "Ductor Dubitantium," or Guide of the Doubting, is an able handbook of casuistry. After ten days' illness he died of fever, 3rd August, 1667, aged fifty-four. Morally he seems to have been one of the most perfect characters of his age. Intellectually he was exceptionally powerful in memory, judgment, and imagination—quite a Spenser among divines. His piety was unaffected, and his learning thorough and broad. Of their several kinds—practical, controversial, and casuistical—his works are of the highest order. Their language is rich, varied, and harmonious; their illustrations splendid and ornate, though formal and sometimes over-minute and affected; his argumentation is clear, distinct, and well put.

In controversial theology William Chillingworth has been generally recognized as a masterly reasoner, one who, as John Locke says, "by his example will teach both perspicuity and the way of right reasoning better than any I know—not to say anything of his argument." He was the son of the Mayor of Oxford, in which city he was born in 1602. Passing in 1618 as a scholar into Trinity College, he graduated M.A. 1623, and was made a fellow, 1628—being about the same time ordained. John Perse (*alias* Fisher), an able Jesuit, having convinced him of the necessity of a living "infallible rule of faith," Chillingworth attached himself to the Church of Rome, and went to Douay. But his godfather Laud, lord bishop of London, argued so forcibly with him that he returned to the communion of the English Church. Another Jesuit, Matthias Wilson, writing in 1630 under the name of Edward Knott, issued a treatise entitled "Charity Mistaken." Dr. Christopher Potter, provost of Queen's College, at the request of Charles I. replied in 1633. Knott rejoined in "Mercy and Truth, or Charity maintained by Catholics." It was in answer to this book that Chillingworth produced his monumental work in 1638, "The Religion of Protestants a Safe Way to Salvation"—a book which is, as Edward Gibbon says, "still esteemed the most solid defence of the Reformation." It ran through two editions in five months. He was almost immediately made chancellor of Salisbury. Knott affirmed "that he destroyed the nature of *faith* by resolving it into *reason*." Dr. Cheynell, the Puritan, rector of Petworth, "prayed that God would give him new light to deny his carnal *reason* and submit to *faith*." In 1640 he was deputed to the Convocation in London, as proctor for the chapter of Salisbury. He, being a zealous Royalist, attended the king and acted as engineer at the siege of Gloucester, August, 1643. Chillingworth being with Lord Hopton at Arundel Castle, was taken prisoner by the Parliamentary army under Sir William Waller. He fell ill, and dying in the bishop's palace at Chichester, was buried there in June, 1644. Dr. Cheynell having delivered at the funeral an admonitory oration against the rationalism of the book, threw it into the open grave. Chillingworth takes up Knott's work part by part and replies to it *seriatim*. This makes it less pleasant reading, but gives it thoroughness. Dr. Thomas Reid considered him "the best reasoner and the most acute logician of his age." For point, ingenuity, and keenness of intellect, there have been few polemic writers capable of equalling William Chillingworth in argumentative power and brilliancy.

Milton was a controversialist of fiercer mood, firmer conviction, and more dexterous fence. In his thirty-third year he issued his treatise "Of Reformation"—taking part with the Puritans. Bishop Hall—of whom we have already spoken as a satirist—in the same year (1641), when he was eighty-seven, published his "Humble Remonstrance in favour of Episcopacy," to which "Smectymnuus" was issued as a rejoinder. James (afterwards Archbishop) Usher, issued a "Confutation" of this work, to which Milton replied in his treatise "Of Prelatical Episcopacy." Hall, undauntedly returning to the charge, published "A Defence of the 'Humble Remonstrance,'" upon which Milton wrote "Animadversions," and in reference to which he issued "The Reasons of Church Government urged against Prelaty." Hall (or perhaps his son) meanwhile sent forth a "Confutation of the 'Animadversions.'" Milton's "Apology for 'Smectymnuus,'" 1642 (prior to which Hall had died), closed this severe and closely contested polemic. In 1642 appeared a "Discourse on Schism," by Mr. John Hales, a famous scholar and divine, born at Bath, 1584, educated at Corpus Christi College, Oxford, who sat in the Synod of Dort, was made canon of Windsor, 1639, and ejected thence during the Rebellion. He delivered an oration at the funeral of Sir Thomas Bodley, founder of the library at Oxford, 1613. Hales died 1656, and in 1639 his "Golden Remaines"—consisting of sermons, letters, and miscellanies—were published. He was, as Bishop Pearson, the expositor of "The Creed" states, "as great a master of polite, various, and universal learning as ever yet conversed with books," and as Lord Clarendon affirms, "one of the

greatest scholars of Europe." His "Schism" is an earnest pleading for greater comprehensiveness in the church, against the multiplying of tests, and in favour of increased simplicity of creed and practical charity of life.

In theological literature, George Fox (1624–90), founder of Quakerism—son of a Leicestershire weaver of Drayton, and himself bred as a shoemaker—deserves honourable mention, not only for his intense zeal and unwearied labours, but also for his "Gospel Truth Demonstrated," his interesting Journal and Travels, and his numerous Christian epistles. So ought Robert Barclay (1648–90), the Morayshire apologist for the doctrines and principles of the Society of Friends (1676), who greatly influenced not Britain only, but the Continent. William Penn (1644–1718) carried these serious impressions from Oxford to the State of Pennsylvania in North America, where "No Cross, No Crown," gained great popularity.

Thomas Goodwin, D.D. (1600–1679), was a native of Rolesby, Norfolk, student of Christ Church, fellow of Catherine Hall, and lecturer of Trinity Church, Cambridge—of which he became vicar in 1632. Relinquishing his preferments he was pastor of the Independents in Arnheim, Holland. Having become a member of the Westminster Assembly of Divines, he was made president of Magdalen College, Oxford, where he and Owen used to preach on alternate Sabbaths in St. Mary's. Ejected at the Restoration, he took a charge in London, and there died. He was a Hercules in theology, a scholar to whom the Scriptures were as an open casket full of divine jewels. To him as an expositor the most abstruse and difficult texts furnished goodly pearls, and in his works a storehouse of high Calvinism is contained. He is often prolix, sometimes involved and obscure, but always informing and suggestive. His sincere piety, unblemished character, and sterling conscientiousness made him a valued teacher. Of the contents of the five folios which he has bequeathed to theological literature, perhaps the best are—"Christ, the Universal Peacemaker," "The Heart of Christ," "The Trial of a Christian's Growth," and "A Child of Light Walking in Darkness."

Another celebrated contemporary nonconformist was Richard Baxter, whose "devotion and piety" and "subtle and quick apprehension" Bishop Burnet acknowledges. Born at Rowton, Shropshire, 12th November, 1615, after gaining a fair education against great odds by resolute industry, he was ordained by John Thornborough, bishop of Worcester. He laboured in Dudley, Bridgenorth, and Kidderminster, 1641, where the rabble rose against him as a Puritan, yet subsequently learned to love him as a saint. Under Bishop Morley he was "deprived," though he was made an honorary chaplain to Charles II. and was offered a mitre as a bribe to Conformity. His subsequent career was chequered. He was imprisoned, arrested, distrained, and at length, having issued in 1685 "A Paraphrase on the New Testament," he was indicted and tried before Judge Jeffreys. He was fined and imprisoned, but the fine was remitted and the sufferer liberated at the instance of the Roman Catholic peer, Lord Powys. Five years afterwards he entered into "The Saint's Everlasting Rest," of which he had written with so much force, grace, and fervour forty-two years before. Goodwin's voluminousness was only about one-third, and Owen's less than one-half, of Baxter's: a uniform library edition of his works would fill sixty royal 8vo tomes. His mental energy, controversial pungency, combative casuistry, practical good sense, holy zeal, bright spirituality, Platonic variousness, and Demosthenic extemporaneity were all exercised despite confirmed ill-health. "He is said to have preached more sermons, engaged in more controversies, and written more books than any nonconformist of his age," and yet he was highly popular. Of his "Call to the Unconverted," 20,000 were sold in one year. It has been translated into every European language, and is said to be read in several of the dialects of the Indian races. Lord William Russell before his execution sent his hearty thanks to Baxter for his "Dying Thoughts." John Howe (1630–1705), Cromwell's chaplain, has in "The Redeemer's Tears" and other works shown a sensitive intensity of spiritual insight and a lofty majesty of thought nearly sublime. James Harvey (1713–58) attained great popularity by his meditations, dialogues, &c., written with semi-poetic floridity quite unlike his preaching, which was plain and simple. The sermons of Bishop Sherlock (1678–1761) are learned, elegant, well-reasoned, and arranged. He displayed commanding capacity as a controversialist against prevalent infidelity.

Benjamin Whichcote (1610–84) was reckoned by Baxter among the best and ablest of the nonconformists. He was a man of much originality, learning, and piety, greatly in favour of freedom of conscience, and a commender of Plato, Cicero, and Plotinus to his pupils—among whom there were such men as John Wallis, D.D. (1616–1703), scholar, logician, mathematician, and divine; John Smith (1618–52), author of "Select Discourses;" and John Worthington, who edited these Discourses, and wrote a life of his friend and fellow-student. Whichcote was provost of King's, and professor of divinity. In 1649 he resigned the living of Cadbury to Dr. Ralph Cudworth. At the Restoration he was ejected from his college offices, but was afterwards minister of St. Ann's, Blackfriars, and vicar of St. Lawrence's, Jewry, London. His sermons are vigorous, penetrative, and weighty, and his "Aphorisms on Religion" are acute, thoughtful, and concise.

John Owen, though descended from the blood royal of Wales, rejoiced more in being by faith a son of "David's son and David's Lord." His father was minister of Stadham, Oxfordshire, and in that small parish this great divine was born, 1616. He was precocious. He entered Queen's College at twelve, and was A.M. when nineteen. For leading a resistance to some Romanizing innovations of Laud, he required, when twenty-one, to leave the university. He took orders, but no charge. To Sir Robert Dormer and Lord Lovelace he acted as chaplain. Taking the part of the Parliamentarians he went to London, published "The Display of Arminianism," and was first preferred to the living of Fordham, which he exchanged for Coggeshall. He acquired the favour of Cromwell, whom he accompanied to Ireland and Scotland. In 1651 he was made dean of Oxford University, and shortly afterwards vice-chancellor. While there he issued "The Perseverance of the Saints" (1654), "The Mystery of the Gospel Vindicated," and "Communion with God," and had among his students Locke, Wren, and Sydenham, famous respectively in philosophy, architecture, and medicine; Ken, South, Sprat, and Cumberland in the Church of England, and the not less famous dissenters, Henry, Howe, and Allein. The Restoration sent him adrift, and made him a fugitive. Under Buckingham's brief administration "Owen succeeded in the ministry Joseph Caryl, the learned, pious, elaborate, and critical expositor, who made his ten quartos on the Book of Job a complete text-book of divinity, and gave its readers an opportunity of imitating the patriarch in the grace of patience. Owen too sent forth folio on folio full of prolix digressiveness and erudition—in excess, it is true, yet vigorous in theology, sustained in devotionality, precious for spiritual insight, and valuable for their robust reflectiveness. His "Exposition of the Hebrews" (in four folio volumes) is an exhaustless quarry of lore, logic, and love. His latest work, "Meditations on the Glory of Christ," was finished at Ealing, where he died 24th August, 1683. Recollecting Owen's trenchant anti-Arminian treatises, we remember that John Goodwin, in reply to whom he wrote, was not always a follower of the Dutch divine, but had issued a "Treatise on Justification," 1642, to which Walker and Roborough feebly replied, "The Divine Authority of Scripture asserted" (1648)—an original and ingenious aid to the understanding of the Scriptures—before he produced, in 1651, his "Redemption Redeemed," the ablest and most powerful plea for the freeness of God's grace to repentant sinners, which in that age of religious controversy excited the predestinarian polemics of Lamb, Resbury, and Kendal, as well as of "the two Atlases and patriarchs of Independency," John Owen and Thomas Goodwin.

Dr. Isaac Barrow, born 1630, was the son of a London linen-draper, who followed Charles I. to Oxford, and went with him in his exile. Isaac possessed the paternal pugnacity and loyalty. He was idle and quarrelsome at Charterhouse, though at Felsted, in Essex, he displayed immense

energy and industry. He entered Peterhouse College, Cambridge, 1645, and Trinity College in 1647. Here Bacon, Galileo, and Descartes were his special studies. He passed M.A. in 1652, and by Dr. Hammond's aid was made a fellow of his college. In 1660 he became professor of Greek, in 1662 Gresham professor of geometry, in 1663 first fellow of the Royal Society by election, and first Lucasian professor of mathematics; in 1670 he became D.D., in 1672 master of Trinity, and in 1675 vice-chancellor of his university. As his Lucasian chair prohibited him from holding any benefice involving cure of souls he resigned it in behalf of Isaac Newton, but issued as part of his labours therein his "Mathematical Lectures" and other works, which are recognized as models of sound reasoning in geometry. Though in the very height of fame as a geometrician, yet he followed his own golden maxim, "A straight line is the shortest in morals as well as in geometry," and devoting himself to duty as a divine, having obtained a small preferment in Wales, he resolved to serve the church, and afterwards gained a prebendal stall in Salisbury. He composed sermons massive in thought, rich in learning, choice in diction, and noble in sentiment, but far too copious, pedantic, and polemical for pulpit use; many of them were never preached. Over the whole domain of theology and morals he marched with the step of a master, and he was a cautious and conscientious controversialist. His great "Treatise on the Pope's Supremacy"—which, like his "Sermons," was published posthumously—is a monumental masterpiece of resolutely pursued research and of closely conducted argumentation. Calm, cold, and passionless in his investigation, yet firm and steady in his course, he sheds on all the pathway of his progress the light of a bright, broad, well-trained intellect. On 13th April, 1677, he had preached the Passion sermon at Guildhall; on 4th May, in a lodging near Charing Cross, he died of a fever, aged forty-seven, and was buried in Westminster Abbey. He is the author of the best definition of wit extant, and he could be witty himself. The Duke of Buckingham in an off-taking humour addressed him, "Doctor, I am yours to the shoe-tie;" "I am, my lord, yours to the ground," he replied. "Doctor," the duke persisted, "I am yours to the centre;" "My lord, I am yours to the antipodes," said Barrow. "Doctor," continued the sneerer, "I am yours to the lowest pit of hell;" "Ah, *there*," replied the Doctor, "I am sorry I must leave you."

Robert Boyle, seventh son of Richard Boyle, was born—in a magnificent castle originally built in 1185 by King John—in Lismore, 25th January, 1626. He was educated under Sir Henry Wotton, his father's friend, at Eton, went the grand tour, learned French and Italian practically, and on returning found his father dead, and himself, at eighteen, heir to the estate of Stalbridge. After residing some time with his sister, Lady Ranelagh, who aided greatly in subduing his nature to piety, virtue, and knowledge, he retired to Stalbridge, and devoted himself to study. He "seems to have been designed by nature to succeed to the labours and inquiries" of Lord Bacon. With the scientific thinkers who subsequently founded the Royal Society he early associated himself, and that he might be a member of a learned community took up his residence at Oxford. As an able and sedulous investigator of nature by experiment he added much to the progress of physics, optics, chemistry, pneumatics, and medicine. His mind was essentially reverential, and he wrote much on religious topics, *e.g.* on "Seraphic Love," "The Style of the Scriptures," The Great Veneration that Man's Intellect owes to God," "The Christian Virtues," "The Reconcilableness of Reason and Religion," &c. Lord Clarendon urged him to take holy orders, Charles II. offered to make him provost of Eton, and though in 1680 chosen president of the Royal Society, he refused the honour because scrupulous about tests and oaths. He published the New Testament in Irish, and shared with the East India Company the expense of printing a Turkish version. The four Gospels and the Acts were printed by him in the Malay tongue, and he paid for the publication of Pocock's translation of Grotius' treatise "On the Truth of the Christian Religion." With money he aided many in trouble and straits, and helped to bring out not a few important books by bearing their cost. He died in 1691, having devoted his ample fortune to charitable, scientific, and religious purposes—founding, among other things, the Boyle Lectureship, which was first held by Richard Bentley in 1692. Boyle said, "I use the Scriptures not as an arsenal to be resorted to only for arms and weapons to defend this or that party, or to defeat its enemies; but as a matchless temple, where I delight to be, to contemplate the beauty, the symmetry, and the magnificence of the structure, and to increase my awe and excite my devotion to the Deity there preached and adored."

The point and vivacity of the style and sentiment of the sermons of Jeremiah Seed (died 1747) are justly admired. The treatise on the "Attributes of God," by Stephen Charnock (1628–80), excites intense and serious interest in the matters handled, and admiration of his genius, judgment, and incomparable and irrefragable reasoning. He is a substantial divine. Neither the fine, fervid, apostolical affectionateness of Archbishop Leighton (1613–84), nor his pure piety and sublime spirituality, could reconcile the contending parties in Scotland, and he retired in disappointment from the laborious honour of his episcopate. Holy Henry Hammond (1605–60), in a mildly Christian spirit, carried on the study of theology and church history most laboriously, despite ejection and dejection. Charles I. esteemed him the most natural orator he ever heard. Bishop William Beveridge (1633–1717) is at once plain and solemn, grave and simple. His "Private Thoughts upon Religion" have been of incalculable benefit to many readers. John Flavel (1627–91) was one of the most popular Christian writers of the stirring times in which he lived. He was deprived of his benefice, but his flock was not deprived of the benefits of his fervent and affectionate, plain yet lively preaching, which probed the conscience and stirred the heart. Dr. Thomas Fuller (1608–61) is quaint and conceitful, but of extraordinary merit, his "Holy and Profane State" giving exemplary biographies of persons illustrative of each condition as described in characters and essays. As poet, preacher, historian, and a fascinating writer furnished with quite a storehouse of gossip about the worthies of England, he is readable, interesting, and admirable. "The Resolves" of Owen Feltham contain an extraordinary treasury of exquisitely expressed moral and religious thought. Twelve editions of his works were absorbed in his lifetime, so great was his celebrity. Few writers are so gifted with the power of condensed vigour, apt expression, and originality. Little or nothing is known of his life. He may have been born about 1600. His family belonged to Suffolk, but he was brought up in Cambridgeshire and (probably) educated in Cambridge. He began to write early. His "Resolves," begun in his eighteenth year, were issued in 1627. He was a personal friend of Ben Jonson and of Thomas Randolph. He seems to have "served" in several noble families, was a Royalist, and yet retained the fine healthy holiness of an earlier time. He is supposed to have died about 1678. He was many-thoughted, acute, judicious, and speaks out with an honest earnest Christian's voice.

Francis Atterbury, son of the rector of Middleton, Bucks, was born in 1662, educated at Westminster School and in Christ Church, Oxford. He issued in 1682 a Latin version of Dryden's "Absalom and Achitophel." In "The Battle of the Books," in which Bentley assailed Boyle, and in which Garth, Swift, Aldrich, Temple, and many others took part, Atterbury ranged himself on the side of his pupil Boyle and got dreadfully mauled by the hammer of the great Grecian. He was pugnaciously controversial, and went into the High Church disputes of his time with vehement though rash intrepidity as a pamphleteer. He was made Dean of Carlisle, then Dean of Christ Church, and Bishop of Rochester. He favoured the Jacobites, and personally corresponded with the Pretender. Though he helped to place the crown on the head of George I., he offered to go in his lawn-sleeves with the heralds who should proclaim James III., and was put in prison. He was afterwards "deprived" and banished by the Peers. He went to Brussels, Paris, and Montpellier; in the former he intrigued with James, and in the latter devoted himself to literature. He was induced to return to

Paris, and had just completed his seventieth year when he died there, 15th February, 1732. His style is perspicuous, polished, easy, and forcible. His mastery of the English language was almost perfect, and as an orator, preacher, and writer he had few equals and no rivals. His controversial writings are ingenious, sarcastic, powerful, and exceedingly dexterous in fence. He liked the glittering play of the weapons he wielded so well, and cared perhaps as much for the show they made as the cause they were used in. Over all the finesse of cultured art is thrown. The following passage on the Golden Rule is (apparently) marked by Burns in a copy of Atterbury's sermons, which he presented to a village library:—

"Human laws are often so numerous as to escape our memories; and sometimes so darkly and inconsistently worded as to puzzle and embarrass our understandings. But here is a law attended with none of these inconveniences; the grossest mind can scarce misapprehend it, and the weakest memories are capable of retaining it; how can there be any one so absurd and unreasonable as not to see and acknowledge the absolute equity of this command in theory, however he may swerve and decline from it in his practice; and to agree upon it as that golden mean which, if universally observed, would make the world universally happy; every man a benefactor, a good angel, a deity, as it were, to his fellow-creatures, and earth the very image of heaven."

The two Erskines—Ebenezer (1680-1754) and Ralph (1685-1752)—the co-founders of the Secession Church in Scotland, as well as their father Henry Erskine (1624-96), were all celebrated as preachers. Henry was thrice imprisoned as a stubborn Conventicler, and under him Thomas Boston received his first religious impressions. Ebenezer defended the Calvinistic doctrines of "The Marrow of Modern Divinity," written by Edward Fisher, M.A., 1627, and was, with other three ministers, ejected from the church. Four volumes of his sermons have been published, remarkable for unction, zeal, and grace. Ralph adhered to Ebenezer's protest, and his sermons, as well as his "Gospel Sonnets," "Song of Solomon," "Job's Hymns," &c., are marked by fervency, pathos, point, and simplicity. Thomas Boston (1676-1732) has been a precious teacher to many homes and hearts in Scotland by his "Human Nature in its Fourfold State (1720): (1) as he *was* originally, (2) as he *is* in his sin, (3) as he *should be* through grace, and (4) as he *will be* in glory." His "Crook in the Lot," practical, stimulating, and consolatory, was a much-bought chap-book for a century. His "Body of Divinity," though prolix, is greatly valued by the good and wise even yet. His youngest son, also named Thomas (1713-67), was one of the founders of the Relief Church (*i.e.* a church for the relief of Christians oppressed in their privileges). He was opposed to patronage, and in favour of free communion, and next to Whitefield was esteemed one of the most reviving preachers of his day. In associate action he allied himself to William Gillespie (1708-74), minister of Dunfermline, whose "Treatise on Temptation," a work full of excellent matter, was edited by Dr. John Erskine (1721-1803), colleague of (though of a different school of theology and politics from) Dr. William Robertson in Greyfriars Church, Edinburgh, friend of Jonathan Edwards, the American metaphysician and divine, and the opponent of John Wesley. Erskine's mode of preaching is described by Sir Walter Scott in "Guy Mannering" as exhibiting "much learning, metaphysical acuteness, and energy of argument" —praise which his volumes of sermons thoroughly deserve. Nor should we leave unmentioned John Brown (1722-87) of Haddington, a weaver's son in Carpow, early left an orphan, shepherd, pedlar, schoolmaster, pastor, self-taught linguist, professor, commentator, very nearly the most voluminous of Scottish theologians, and the most influential of ministerial minds, whose "Self-interpreting Bible"—found in almost every home—formed the great storehouse of the common Christian knowledge of pastors and peasantry for a century. It is both valued and valuable still.

Among the Scottish divines who aimed at rivalling in effectiveness of style the more notable of the English theologians, a high place is held by Dr. Hugh Blair (1718-1800), whose "Lectures on Rhetoric and Belles Lettres" (1783) were the most systematic investigation and exposition of style made up till that time in Britain. His "Sermons" (of which five vols. were issued 1777-1800) are correct and elegant in diction, polished in periods, and regular in paragraphs, though wanting in warmth and animation. They were translated into French and German. The executors of John Logan (1748-88)—famous as a minor poet, and known as the author of "Runnymede," a tragedy (1783), and "Elements of the Philosophy of History" (1781)—issued two volumes of his sermons, which are elegant, imaginative, perspicuous, and original, but deal rather with moral questions than religious truths. Dr. William Robertson (1721-93), the historian, who was one of Logan's executors, and a defender of Home the dramatist, though he only published one sermon, noteworthy for felicity of composition and power of reasoning, which he delivered for the Society for the Propagation of Christian Knowledge (1755), was distinguished for elegance and good taste as a preacher, and as the leader of the moderate party in the ecclesiastical establishment became the model of many ministers. The Rev. Robert Hardy was energetic and controversial. In the works of Dr. James Macknight (1721-1800), the disciplined theologian finds learning without pedantry, and piety without enthusiasm, and the general reader good sense, acuteness, and an immense amount of instruction. Alexander (known as Jupiter) Carlyle (1722-1805)—friend of Smollett and Collins, defender of Hume, and one of the leaders among those men who in Scotland conferred lustre on the latter part of the eighteenth century—was a man of broad mind, powerful character, and effective eloquence, though only two of his sermons have been published. George Campbell (1719-96)—whose "Philosophy of Rhetoric" (1776) contains many scholarly and thoughtful things—in his "Dissertation on Miracles" (1763), levelled against the scepticism of Hume, won high honour, which his "Occasional Sermons" and his lectures on "Pulpit Eloquence" fully maintained. Robert Wallace, D.D. (1697-1771), was a political economist and a divine. His "Dissertation on the Numbers of Mankind" (1753) astonished David Hume, and originated the speculation of Malthus. Archibald Alison (1757-1839), whose "Essay on Taste" (1790) is refined in fancy, ingenious in speculation, and melodious in style, issued in 1809 "Sermons," in which sacred wisdom is enshrined in beauty, and the teachings of virtue are enforced with fascinating power and charming attractiveness.

SECTION II.—PHILOSOPHY AND MORALS.

John Locke, as an advocate of human liberty and independence of conscience, holds a high place. He is the philosopher of toleration, civil and religious, and he did not hesitate to suffer for his opposition to one party or his critical animadversions on the other. His claim of freedom for the human understanding, in the age in which he lived, is of historic significance. Born at Wrington, near Bristol, 29th August, 1632, he was educated at Westminster School and in Christ Church, Oxford, where, discarding Aristotelianism, he studied Bacon and Descartes. He found that he would require to reconsider the whole question of the nature, qualities, and powers of man's mind, not with the pedantic measurement of a mechanical surveyor, but with the accuracy of a careful searcher into all that can be known and learned of it by diligent investigation. This he did in his celebrated "Essay concerning Human Understanding"—begun 1670 and printed 1690. It did not take its final shape till it had reached the sixth edition. Its aim is "to inquire into the original certainty and extent of human knowledge, together with the grounds and degrees of belief, opinion, and assent." In it Locke tries to employ the Baconian method of observation and experience as the basis of a theory of human knowledge. Though it is an excellent specimen of the best prose of the time, as it was written for popular use, it is defective in that unity of expression and scientific rigour of statement by which a philosophical treatise should be marked. Hence differing schools of thinkers profess to found their system upon Locke's theory, and may quote apt sentences from the work to show that his views implied theirs. He decried the notion that there are innate ideas—*i.e.* characters stamped into or written on the soul; and affirmed that we derive from experience, as (1) sensation and (2) reflection, all our knowledge. By memory, comparison, and association we retain,

arrange, and aggregate it into the moulds and forms of thought; but mind is not recognized by him either as an originating faculty or an independent modifying force. In doing so Locke either really or apparently opposed several generally accepted truths of a philosophical, practical, and scientific nature, and considerable controversy arose, not so much on the validity of his psychological system as on the assumed effects of his intellectualism on the holding of these views. Professionally he devoted himself to medicine, politically to the furtherance of liberty, and religiously to the reconciliation and union of all sects of professing Christians—an idea which William III. favoured. Hence his letters on "Toleration" and his "Reasonableness of Christianity." For the opinions expressed in the latter work he was attacked by John Edwards, D.D., Cambridge, in a powerful but somewhat bitter controversial spirit. To this writer Locke replied in two tractates in "Vindication of the 'Reasonableness of Christianity.'" He was also engaged in a controversy with Edward Stillingfleet, bishop of Worcester, the distinguished defender of Protestantism in the reign of James II. Founding upon some passages in Locke's essay, Stillingfleet accused him of subverting the very foundations of Christian faith in a "Defence of the Doctrine of the Trinity." Locke rebutted the charge with indignation and power. During his later years Locke became a severe student of Scripture, and produced a valuable "Paraphrase and Notes" of St. Paul's Epistles, preceded by an essay on the proper understanding of them. His style, though sometimes rather prolix, is the most pellucid of any of the authors of his age. He held several offices, but had to flee to Holland because charged with favouring Monmouth's expedition, and his name was erased from the roll of the students of Christ Church. In failing health, after his return, he resided with Lady Masham, daughter of Dr. Cudworth, at Oates, in High Laver parish, where he died 18th October, 1704.

Anthony Astley Cooper, third earl of Salisbury, was born in London, 1671. His "Enquiry Concerning Virtue" was first published in 1699. He also wrote "Letters on Enthusiasm," "The Moralist," a philosophical rhapsody, of which Leibnitz spoke most favourably; "Sensus Communis; or an Essay on Freedom, Wit, and Humour;" his "Soliloquy; or Advice to an Author" (1710). In Italy he composed his "Judgment of Hercules" and his "Characteristics." A revised issue of his best works appeared after his death, aged forty-two, in 1713. He defined morality as the proper balancing of the social and selfish appetites, and so seeking good for its own sake. It is independent in its origin and nature, and is therefore a reflex sense, not only, as Clarke teaches, of the fitness of things, but of right and wrong in themselves. John Brown, D.D. (1715–66), wrote, at the suggestion of Bishop Warburton, three "Essays on the 'Characteristics'" (1751), including (1) "Ridicule as a Test of Truth," (2) "Motives to Virtue," (3) "Revealed Religion." The ability and acuteness displayed in the second essay on the relation of virtue to happiness are very marked. The book to which, more than to any other single work, Bishop Butler's "Analogy" was designed as a reply was "Christianity as Old as the Creation" (1732), by Matthew Tindal (1657–1733), which taught that natural religion—*i.e.* the achieving of human perfection—is complete and sufficient, and has only been republished in Christianity. Richard Price (1723–91), issued in 1757 "A Review of the Principal Questions," in which he says there are three distinct elements in morality: (1) a conception of right and wrong, (2) a feeling of beauty and deformity, and (3) a power of designating actions as good or ill—which power is the understanding. A sense is a mode of feeling, the understanding is a vital energy of mind, and is the guide and superintendent of the operations of our other faculties. Morality is an intelligent perception, reception, and performance of what is good. Henry Home, Lord Kames (1696–1782)—author of an excellent work on "The Elements of Criticism" (1762), "Sketches of the History of Man" (1773), "Hints upon Education, chiefly concerning the Culture of the Heart" (1781), besides many legal and miscellaneous writings—set forth in his essays on the "Principles of Morality and Natural Religion" (1751), the power of the principle of sympathy to stir the conscience or moral sense—which has all other moral principles, desires, and affections under its immediate and entire control—to the examination, determination, and practice of what is right.

Bernard de Mandeville, born at Dort in Holland, 1670, studied physic, and having obtained his degree, came over to England. Here he published several books of a clever, ingenious, but perverted kind: "The Virgin Unmasked" (1709), a coarse dialogue between an old maiden aunt and her niece on love and marriage, a tract on "Hypochondria" (1711), "The Grumbling Hive; or Knaves Turned Honest" (1714). This book—about 400 lines of octosyllabic verse, with notes—was declared by the grand jury of Middlesex to be injurious to morality when enlarged in 1723, and it was vigorously attacked in various publications. In 1720 he issued "Free Thoughts on Religion," and some time afterwards a whimsical and paradoxical work entitled "An Inquiry into the Origin of Honour and the Usefulness of Christianity in War." Mandeville died in 1733. Addison says he appeared like a parson in a tye-wig, but Sir John Hawkins says he was pensioned by some Dutch merchants and spirit dealers to write in favour of gin-drinking and immorality. "The Fable of the Bees; or Private Vices Public Benefits"—a reissue and defence of the "Grumbling Hive"—in 1732, was opposed by Dr. Fiddes in a "General Treatise on Morality" (1724); and by John Dennis (1657–1734) in "Vice and Luxury Public Mischiefs." Thomas Bluett—besides being author of an able "Life of Job"—in his "Enquiry whether the Practice of Virtue tends to the Wealth or Poverty, Benefit or Disadvantage of a People" (1725), objected to the pleas offered by the author of the "Fable of the Bees" for the usefulness of vice and roguery." Bishop Berkeley, in the second dialogue of his "Minute Philosopher," combats Mandeville's selfish theory of morals and the social utility of vice, asserts the dignity of human nature, maintains that pleasures are generally different, and shows that sensuality degrades those who indulge in it. William Law also wrote remarks on the "Fable of the Bees." Mandeville affirms that man, like all other animals, is irresistibly solicitous only about his own gratification. Lawgivers and politicians, seeing that the passions of man require curbing, began to inflame his pride as a noble being; and his (so-called) virtues are the offspring of this flattery. He asserts pride, avarice, self-indulgence, are stimulants to exertion, and are the appetites which induce toil to gratify them. The six dialogues in the second volume contain a large amount of droll, satirical, odd, but often offensive though ingenious remarks. Bolingbroke and Pope, however, did little more than polish and cleanse the outside of the cup and platter of the selfish theory of morals in that "Essay on Man," the speculative opinions of which the former drew up and the latter versified.

Thomas Burnet (1635–1715), clerk of the closet to William III., and author of "The Sacred Theory of the Earth" (1684)—a work of magnificent imaginativeness and majestic march of style, though as an exegetical exposition of Scriptural truths not worthy of implicit reception—published, 1697 and 1699, three pamphlets, containing remarks against Locke's views. Mrs. Catherine Cockburn, *née* Trotter (1679–1749)—authoress of "The Flowers of the Forest," the tragedies of "Fatal Friendship" (1698), "The Unhappy Penitent" (1701), "The Revolution in Sweden" (1706), &c.—in 1702 defended Locke against Burnet in a treatise precise in logic and clear in expression. J. A. Lawde in 1694 issued "The Nature of Man," opposed both to Hobbes and Locke; Richard Burthhogge, M.D., a Devonshire J.P. who died 1694, in his "Essay on Reason," dedicated to Locke, criticises him keenly, and maintains that phenomena "do no more exist without our faculties, in the things themselves, than the images that are seen in water or behind a glass do exist in those places where they seem to be." This "favourer of fanatics," as Antony Wood calls him, anticipated Kant and Hamilton in the explicit assertion of "the relativity of human knowledge." John Sergeant (1621–1707) contends against the fancies of the Ideists, that notion or cognition is peculiar to man, and that knowledge is not representative but real. Henry Lee's "Anti-Scepticism" (1702) controverts Locke in four books, maintaining that we cannot avoid having perceptions and forming judgments, that idea ought not to be extended from

"image of object" to "object of thought," that his views destroy the authority and fixedness of moral ideas, and are sceptical in tendency. Peter Brown, provost of Trinity College, Dublin, who died 1735, issued in 1728 "The Procedure, Extent, and Limits of the Human Understanding," and in it affirms that "we have *ideas* of sensible objects only," and "know only the operations of spirit." The latter are pure, the former mixed, and illation is not employed on simple, but on complex notions. Vincent Perronet replied to Bishop Browne with pertinent acuteness (1736–38), and Samuel Bold in 1699 threw himself zealously into the arena in defence of Locke's theory of ideas, and the discussion of the necessary immortality of the thinking substance. Edmund Law, D.D. (1703–87), bishop of Carlisle—who in 1772 edited Locke's works in three vols. 4to—in his "Inquiry into the Ideas of Space, Time," &c. (1734), dissented from his views on innate ideas; and Zachary Mayne, in "An Essay on Consciousness" (1727), initiates in philosophy the distinction between consciousness and self-consciousness, on which Reid and Hamilton insist.

Influenced by Locke's theory of representation and volition, George Berkeley, D.D., bishop of Cloyne (1685–1753), began to meditate on the metaphysical meaning of the material world. His "Theory of Vision" appeared in 1709, "The Principles of Human Knowledge" in 1710, "Three Dialogues between Hylas and Philonus" in 1713, and "Alciphron, or the Minute Philosopher," in 1732; all his works have been issued in a splendid edition under the care of Professor A. C. Fraser, LL.D. (1871). Berkeley was born in 1684 at Killerin, near Thomastown, in Kilkenny county, entered Dublin University in 1702, was made fellow in 1707, took the grand tour in 1713–20, was appointed dean of Derry in 1724, proposed to found a college in Bermuda for the training of our transatlantic colonists, and sailed for that purpose to Rhode Island in 1728, returned and became bishop of Cloyne in 1734, and died in 1753. He stands in the front rank of the Idealist philosophers who followed Locke. He refuses credence to the common belief that those unthinking objects which in the mass we call Nature are real and material, but lays it down as a scientific fact that what we see and feel, hear, taste, and smell, are only sensations, that our ideals of real objects are only the phenomena of our own minds, and that therefore (1) there exists in the world nothing beside these objects—whose *esse* is *percipi*, *i.e.* which exist because perceptions arise in us; and (2) we have no immediate certainty except that of the existence of our own thoughts. This phenomenalism is the order of God, "in whom we live, and move, and have our being." Hence the universe of realities exists only in the mind of the Creator, and exists in us representatively, in intellect and thought, only through impressions made upon us such as He wills, and all the phenomena of life and of the universe are the action of the Deity upon our spirits without the intervention of a senseless and inert mass called by us *matter*. It is only when misunderstood that opponents can say, by a *quaternio terminorum*,

> "When Bishop Berkeley says, 'there is no matter,'
> No matter then what Bishop Berkeley says,

or can think him rebutted by the clever (illogical) epigram,

> "What is mind? It is no matter.
> What is matter? Never mind!"

Berkeley is explaining mental phenomena. He does that within the circle of thought itself, and refuses to go beyond mind for what he finds therein. The natural philosopher is free to explain Nature in any way he chooses to call science. It lies before the philosopher in calm and lustrous dignity, an awful reality, as God's creation, but so far as it is thought it is only a phenomenon of mind.

The notion that metaphysics tended to annihilate the universe led Isaac Newton (1642–1727) to exclaim, "Beware of metaphysics!" But his own doctrine of universal gravitation is quite distinctly metaphysical (Gr. τα μετα τα φυσικα)—an ideal gained through, but really lying beyond, physical impressions. Pope in his epigrammatic couplet unites and harmonizes Newtonian physics and Berkeleyan metaphysics thus:

> "Nature and Nature's laws lay hid in night;
> God said, 'Let Newton be!' and all was light."

His various profound scientific and mathematical treatises being written in Latin do not hold a place in English literature, but his "Observations on the Prophecies of Holy Writ," particulary of David and St. John, and "The Chronology of Ancient Nations" appeared after his death.

Andrew Baxter (1686–1750), born and educated in Old Aberdeen, with considerable ingenuity, acuteness, and novelty, maintained in an "Inquiry into the Nature of the Human Soul" (1737), against Berkeley, that matter is real besides holding that matter is neither eternal nor uncreated. In "Thoughts Concerning the Human Soul," by William Coward, M.D., Oxford (1656–1725), a controversy was originated which lasted a century, and gave occasion to the issue of quite a library of literature. He affirmed that a spiritual immortal substance, united to the human body, is a heathenish invention and not consonant with philosophy, reason, or religion. His book was burned by the hangman in 1704. Henry Dodwell (1641–1711), Camden professor of history in 1688, deprived in 1691 as a non-juror, in 1706 issued "An Epistolary Discourse" to prove that the soul is a principle naturally mortal, but immortalized actually by the pleasure of God to punishment or reward by the Divine baptismal Spirit—conveyed by bishops alone. Richard Bentley, Samuel Clarke, Jeremy Collier, John Norris the poet, Henry Layton, Robert Bragge, Thomas Broughton, and a host of others argued the question with a fervid intensity of feeling and a thorough devotion of heart which show absorbing and passionate religiousness. The general logical and theological opinion of the time may be expressed thus:—"The soul is immortal because it is immaterial, for that which is immaterial has no principle of dissolution in it."

Joseph Butler (1692–1752), born at Wantage, educated at Twekesbury and Oxford, became Preacher of the Rolls in 1718, bishop of Bristol in 1738, and of Durham in 1750. His "Sermons" (1726)—written in opposition to Hobbes, Mandeville, Shaftesbury, &c.—are well argued and weighty, and no work in the English language has been so influential in moral philosophy and on religious thought as his "Analogy of Religion, Natural and Revealed, to the Constitution and Cause of Nature" (1736). After stating that difficulties in thought are found in Nature as well as in Scripture, and inferring that therefore we should no more deny Scripture than Nature, but strive to understand both as, just on this account, probably derived from the same author, he treats (1) of natural religion, and in this section considers the probability of a future life, the government of God as a system of rewards and punishments, and man's estate as one of probation, implying moral discipline—trials, difficulties, and dangers; the effects of the doctrine of necessity on human life and habits; and the incomprehensibility of God's government: (2) of revealed religion—the importance of Christianity; the weakness of the argument against revelation that it is miraculous; our inability to know what a revelation ought to be, and the probability that things that seem difficult should be contained in it; that Christianity is ill understood; the Mediator it offers; the evidence in favour of Christian faith; and the objections to arguing against religion, since nature may also be argued against. He opposes Locke on the question of personal identity. The whole treatise is cautious, compact, consistent, reasonable, and reverent—a massive, weighty, and powerful statement of thoughtful faith.

Samuel Clarke, D.D., born at Norwich, 1675, and educated at Caius College, Cambridge, became rector of St. James's, Westminster, and died 1729. As Boyle lecturer he delivered a series of discourses on the being and attributes of God, and the truth and certainty of the Christian revelation (1704–5). He is accurate but monotonous in style, a wary and skilful controversialist, and so well disciplined in scholastic logic that Voltaire called him a reasoning-mill. Though he followed the *a priori* system of reasoning pursued by Spinoza, Clarke opposes his argumentation. He is a very voluminous writer himself, and has excited many others to write. Ten volumes of his sermons have been published. His "Paraphrase of the Four Gospels," and his "Exposition of the Church Catechism," are even yet worth reading. His controversial contests with Waterland, Dodwell, Anthony Collins, elicited many volumes, and readers of Hutcheson, Smith, Price, and

Mackintosh will find evidences of his influence on them and their theories.

Francis Hutcheson (1694-1747)—who, though born in Ireland, revived speculative philosophy in Scotland—was trained for the church but became a teacher in Dublin (1721-29), and was then appointed professor of moral philosophy in Glasgow. His "Inquiry into the Original of our Ideas of Beauty and Virtue" appeared in 1725, and in 1728 his "Essay on the Nature and Conduct of the Passions and Affections." This contains fine and refined discussions against the theories of Dr. Samuel Clarke and Mr. William Wollaston. His mind was fresh and vigorous, original and independent. He maintained the existence in us of a power to discern good in itself, a moral sense inherent in the soul, an inner determining feeling which approves good and condemns evil. His "Introduction to Moral Philosophy," and his "Posthumous Lectures," were issued after his death. "Butler and Hutcheson," as Sir James Mackintosh remarks, coincided in the two important positions that (1) disinterested affections and (2) a distinct moral faculty are essential parts of human nature. Hutcheson is a chaste and simple writer, who imbibed the opinions without the literary faults of his master Shaftesbury. He has a clearness of expression and fulness of illustration which are wanting in Butler.

David Hume (1711-76)—notable as a philosopher, a diplomate, and a historian—transformed the empiricism of Locke into scepticism, and originated the transcendental "critique" of Kant. Even so recently as 1868, F. Papillon claims Hume as the precursor of Auguste Comte. *Cause* is with him a mere habit of thought. We can perceive no objective connection between causes and effects, and cannot therefore reason from nature up to nature's God. All the materials of thought are supplied to us by experience—external or internal. Perceptions combine into conceptions, by the three principles of association, (1) similarity, (2) contiguity in space or time, and (3) correlation of cause and effect. Knowledge consists of (1) facts, and (2) ideas. The former we can examine but cannot manipulate as we will; the latter we can, by the sole agency of the faculty of thought, arrange, systematize, and operate with as we choose. But this gives us no guarantee of their reality—geometry would be true were there neither triangle nor circle in the universe. The resistance of facts to our manipulation, unless we know their qualities and harmonize our processes with them, distinguishes the ideal from the real. But to reason from the data of experience to any field transcending its limits is an illicit overleaping of the bounds of intellection. This was a logical demolition of the prevalent philosophy, which accepted sensational science, and by asserting a basis for belief in faith, evaded reasoning by dogmatism. Hume was, in this sense, a destroyer. He cleared from the field of philosophy every structure raised by aught but reason; and held that the contents of the invincible entity, which we call intellect and designate *I*, is the only certainty known to us—whatever its suggestions may imply or make possible. He was only a *philosophic* sceptic, but not personally a *religious* one. In his own moderate unenthusiastic fashion he held the accepted creed. His "Essay on Miracles" is not really a hostile tractate against religion, but an ironical *argumentum ad homines*, showing that the common-sense school (who were all pledged theologically) held philosophic principles which were irresistibly destructive of the very basis of religion, and imply that as they could not renounce their religion they must give up their philosophy. Hume was born in Edinburgh, 26th April, 1711, had a scanty education, tried and gave up law and commerce, lived some time in France (1734-37), and there wrote his "Treatise on Human Nature" (1739). It "fell still-born from the press." His "Essays" (1742) were more favourably received, and in 1746 he was, unsuccessfully, candidate for the chair of moral philosophy. He went as secretary of embassy to Vienna and Turin, and remodelled his former philosophical work into (1) "An Enquiry Concerning Human Understanding," 1748; (2) "An Enquiry Concerning the Principles of Morals," 1751. Subsequently he issued, in 1752, "Political Discourses," and in 1755 "The Natural History of Religion." In 1752 he was appointed curator of the Advocates' Library, Edinburgh, and this gave him the opportunity of writing his "History of England," and becoming the first of the great triumvirate of the historians of the eighteenth century—Hume, Robertson, and Gibbon. Hume's is not a history in the modern significance of the term. It is wanting in accuracy, impartiality, critical sagacity, and width of sympathy. It is rather a (somewhat one-sided) philosophic review of the currents of English history, and even as such contains many reflections fitted to instruct, elevate, and guide the student of the life of the past. His political writings inspired Adam Smith and Dugald Stewart with those principles which are accepted by the civilized world. In 1763 he was secretary of the British embassy to France under the Earl of Hertford, present at the signing of the peace of Versailles, and was the admiration of Paris. On his return he was made under-secretary of state, and conducted the diplomatic correspondence of the foreign office. He retired in 1769, and died in Edinburgh, 26th August, 1776.

Among the most distinguished writers on mental and moral philosophy taking part in the stir excited by Hume's writings we may mention David Hartley (1705-1757), who by his "Observations on Man" (1749) gave a definite form to the Association theory suggested by Hobbes, admitted by Locke (in the fourth edition of his Essays), and advanced by Hume. Hartley's system involves three tenets: (1) that vibrations are excited, propagated, and sustained in the brain as the material instrument of sensation and motion, through which ideas are presented to the mind; (2) that there is an action of association in the mind which is distinguished by (*a*) vividness and (*b*) frequency, is (*a*) simple or (*b*) complex, and manifests itself as (*a*) synchronous and (*b*) successive; and (3) these associations are the results of vibrations—which are pleasant if congruous, painful if incongruous, and so induce assent or dissent, and excite a moral sense and the recognition of God. Joseph Priestley, LL.D. (1733-1804)—physicist, publicist, philosopher, and theologian—was the successor and disciple of Hartley, and reissued "Hartley's Theory of Mind" (1775), with disquisitions intended to prove (what its author explicitly disavowed) that it led to materialist conclusions. Priestley was a remarkable man, a severe cross-examiner of all thought, and fearlessly independent in his search for truth. He laid the basis of the chemistry of the gases; wrote thoughtfully and voluminously on philosophy and theology, and was an earnest advocate of political, religious, and intellectual freedom. He evidently liked the charge, the onset, and the encounter of controversy. A continuous warfare of pamphlet, tract, and volume prevailed about him in zealous give and take. In a shameful outbreak of fanaticism and ignorance at Birmingham in 1791, Priestley's house was sacked and burned, his library and laboratory destroyed, and himself compelled to flee. He went to America, where he died. Priestley's examination of the doctrine of intuitive beliefs taught by Reid, Beattie, Oswald, and the Scottish school generally, issued in 1774, is one of his strongest efforts in philosophical criticism. His works have been published in twenty-five volumes, royal 8vo (1817-35). Birmingham erected a handsome statute to his memory in 1874.

The name of Adam Smith is recognized in every civilized land as that of the man who demonstrated that freedom of industry and commerce lies at the basis of the wealth of nations. He was born at Kirkcaldy in 1723, and studied at Glasgow and Oxford. In 1761 he was chosen professor of logic, and next year accepted the chair of morals. In his "Theory of Moral Sentiments" (1759) he gave a refined and instructive analysis of the principles of morality, expressed in language simple and dignified, illustrated by a lively and chaste imagination, and sustained with vigour of argument. He objects to the self-interest of Hobbes, the utility of Hume, and the benevolence of Hutcheson, and maintains with skill, clearness, feeling, and eloquence that sympathy is the ground or primal sentiment which links reason, formulates the rules of morality, and impels us, almost involuntarily, to classify the habits and actions of men into virtuous and vicious. In this he mistakes, we think, the *motive to* for the *law of* action. In economics Smith is at once the Copernicus and the Newton of politics and finance, as well as the Bacon of statesmanship—although, perhaps, he leaves too much unnoticed in his work the one element in the wealth of

nations most worthy of consideration—the originating might of the human mind—an element the value of which Watt, Arkwright, and Henry Bell almost immediately signalized. Smith died in Edinburgh, 1790.

Dr. William Paley (1743–1805), as a fellow of Christ's Church, Cambridge, elaborated that popular theory which in 1785 he published in "The Elements of Moral and Political Philosophy." It is rather a critical compilation and a compromise than an original and determinate work. It is really difficult to see the distinction between the utility of Hume and the expediency of Paley. His definition is a very good practical working rule of life for those who accept its premises, but it is scarcely a philosophical one—"virtue is," in its end or aim, "the doing good to mankind in obedience to" (*i.e.* having for its law or embodied rule) "the will of God, and for the sake of everlasting happiness." This, when reduced to its lowest terms, may be taken to mean "whatever is (really) advantageous is right. Paley's "Horæ Paulinæ" (1790), "Evidences of Christianity" (1794), and "Natural Theology" (1802) attained great celebrity by their charm of manner, mastery of detail, and skill in presentation. The works of the Archdeacon of Carlisle were long regarded as an epitomized "truth made easy."

Thomas Reid, born in the manse of Strichan, Kincardineshire, 26th April, 1710, was educated for the church. Dr. George Turnbull, author of "The Principles of Moral Philosophy," was his teacher. He became librarian of Marischal College, an office which an ancestor, Latin secretary to James I., had endowed. After a short time spent in a journey through England, he was in 1737 inducted minister of New Macher, whence in 1751 he was promoted to be professor of moral philosophy in Old Aberdeen. Here he projected a literary society, many members of which subsequently acquired reputation—*e.g.* George Campbell, D.D., who replied to Hume in his "Dissertation on Miracles" (1763); James Beattie, LL.D., poet and moralist; Alex. Gerard, D.D., author of essays on "Taste" (1759) and "Genius" (1774); Thomas Blackwell, author of "An Inquiry into the Life and Writings of Homer" (1737), "Memoirs of the Court of Augustus" (1753); and many others. In 1764 Reid published his "Inquiry into the Human Mind on the Principles of Common Sense"—having first submitted it to Hume, against whom it was mainly directed. Hume expressed satisfaction with the perspicacity and philosophic style of this reply to his reasonings. On the resignation of Adam Smith (1764), Reid was chosen to the chair of morals, Glasgow. Having retired in 1781, he issued his essays on "The Intellectual Powers of Man" (1785), and on "The Active Powers" (1788). He died 7th October, 1796. Reid's main superiority over other metaphysicians lies in the thoroughness of his introspective analysis of mental processes, the clearness of his perception of their phenomena, the precision and simplicity of the manner in which he describes them and states his results. At first he accepted Locke's theory, and received unstartled the Berkeleyan doctrine, but he was astonished and troubled by Hume. He could not see a flaw in the superstructure, and he resolved to re-examine the ground-plan. Hume's invincible *I* he saw was irradiated with consciousness. Experience and intuition unitedly constitute perception, and in an indivisible dualism give a presentation to thought—as ideas. Our reasonings are not merely comparisons of these ideas, but analyses of them as to content, power, and value, according to principles inherent in the constitution of the mind. Thus far he went as an investigator of psychologic facts, but he did not rise to the higher investigation of the organic structure of the intellect in which these phenomena are manifest, so as to find out its fundamental laws. "Common sense" is not a series of opinions, popular and generally accepted, nor even a faculty of reason; but the power of knowing possessed by the human mind and called into exercise by experience—(1) *intellectual*, resulting in sensation, memory, perception, abstraction, judgment, reasoning, taste, consciousness, moral perception, and social sympathies; (2) *active*—powers not of affection or desire only, but of determination and action—attention, deliberation, and purpose. Similar opinions to those of Reid were rather popularly than philosophically advanced by James Oswald, D.D., in his "Appeal to Common Sense in Behalf of Religion" (1768); by James Beattie (1735–1803), in his "Essay on Truth"—an exceedingly popular book, which went through four editions in five years (1770–75)—and his "Elements of Moral Science" (1790–93); by Adam Ferguson (1724–1816), who gained the Edinburgh chair when Hume was disappointed (1746), author of an "Essay on the History of Civil Society" (1767), "Institutes of Moral Philosophy" (1769), and "History of the Roman Republic" (1783).

Jeremy Bentham, jurist and reformer, was born in London 1748, and during a long life of eighty-four years proved himself estimable as a man, useful as a citizen, and capable as a thinker. His moral speculations hold really a secondary and subordinate place, and are introductory only to his innovating doctrines on jurisprudence, law, and government. He was not so much in search of a theoretically accurate, as a practically workable principle of morality. His statement that "Nature has placed mankind under the government of two sovereign masters—pain and pleasure: it is for them alone to point out what we ought to do as well as to determine what we shall do," is laid down by him as a practical foundation on which "to rear the fabric of felicity by the hands of reason and law." As a social maxim, whatever tends to the realizing (1) of the greatest possible happiness of the greatest possible numbers, and (2) secures that the least possible inconvenience should press on the fewest possible, is a good working one for society in regard to jurisprudence, law, and politics. His first systematic work, "An Introduction to the Principles of Morals and Legislation," though printed in 1780, was not published till 1789. In it he sifts and anatomizes very skilfully, though somewhat sarcastically, *nine* differing ideals of moral theory. He acknowledges that his own idea of *utility* can be traced to Helvetius and Priestley, and he thinks it expresses the unanalyzed experience of all men. The useful is the right, and ought to be made the obligatory. This, however, he sets up as the public standard of judgment rather than as the private principle of action, and it is possible that "the springs of action" may differ from the utilities to which they are applied in the mere "mill-race" of the lives of many. The *initiative* must differ from the *consequent*.

In any endeavour to follow intelligently the continuous flow of human thought as expressed in the literature of philosophy, theology, and morals, the "Enquiry Concerning Political Justice and its Influence on Morals and Happiness" (1793), by William Godwin (1756–1836), as well as his "Inquirer" (1797) and his "Thoughts on Man" (1830)—in which the theory of human perfectability is assumed rather than argued — ought to be mentioned. Nor can we leave unnamed Dugald Stewart, under whose professoriate (1784–1810) a mental and moral philosophy was taught which has affected the personal character of many of the best public men of the nineteenth century, and much of the political, religious, and educational progress for which our modern life is remarkable, and to whose pen—in his "Philosophical Essays" (1810), "The Elements of the Philosophy of the Human Mind" (1793–1814), and the "View of the Active and Moral Powers" (1828)—we owe the finest restatement of the argument for a moral sense, the most exquisite exposition of the speculations of the common-sense school, and the most felicitous examination and illustration of the doctrines of the Scottish school of Hutcheson in morals and Reid in metaphysics. He was a master-mind as an expositor

HISTORY.—CHAPTER XIX.

THE PROGRESS OF NATIONALITY AND CONSTITUTIONAL GOVERNMENT.

The outward arrangements of society must change with man's changing mind. The complex polity of Europe—grouped as its nations were by diplomatists—resulted in watchful jealousies and in constantly varying coalitions. The Napoleonic appeal to the bayonet had broken up these diplomatic aggregations and made a readjustment of the map of Europe once more necessary. In the settlement that resulted a fresh endeavour was made so to reconstruct states as to prevent the predomi-

nancy of any royal house. The nation at whose cost, by whose power, and through whose persistency the sovereignty of the sword was shattered on the field of Waterloo, though it might have claimed an ascendency, was contented with an equal place among the European Pentarchy—the Five Great Powers. While claiming the common right of self-defence, Britain sought no extension of empire within European territories, and was thus freed alike from temptations to intermeddle and from fear of intermeddlement. Thus, by the casting of its vote, Britain has been able to exert a mediatorial influence among nations, to secure the cessation of obstinate hostilities, to reconcile intending or actual belligerents, and to commend the exercise of humanity or command the observance of justice towards the vanquished in international or revolutionary warfare.

Russia, having retired from the field of fight, had no part in the glorious "hundred days" of 1815, and thereby lost both *prestige* and power in the revision of the political geography of Europe. Alexander devoted himself to the improvement of the state and the consolidation of the empire. He effected great reforms, though he still adhered to autocratic authority. His successor, Nicholas I., even more than he, exercised despotic dominion. Insurrections ensued, but by his energy and courage the autocrat secured submission, and he commenced a career of oppression and aggression which aggravated Europe. Provinces were wrested from Persia, a protectorate was asserted over the Principalities of the Danube, the right of free navigation in the Black Sea, through the Dardanelles, and up the Danube, was claimed, Poland was annexed as a Russian province, the noble effort of the Magyars to escape from Austrian thraldom was paralyzed, the chieftains of the Caucasus were remorselessly suppressed, and Russian appropriations were pressed forward in Central Asia. Everywhere the Russian borders bristled with bayonets, and embroilments were excited. Each success whetted his appetite for the extension of Russian domination, and he resolved to make an incursion into Southern Europe. With this end in view, he claimed an exclusive protectorate of the members of the Greek Church in Turkey. As this would have given him a right to interfere in the internal affairs of that country, the sultan refused to acknowledge the claim. Russia invaded the Principalities of the Danube (July, 1853); Omar Pasha opposed this aggression and defeated the Russians at Oltenitza, checked them twice at Kalafat, repulsed them at the siege of Silistria, and entered into Bucharest in triumph. Great Britain and France regarded with disfavour Russia's arrogance, and declared war against the disturber of the European political settlement, 1854. Their united armies landed near Eupatoria, advanced towards Sebastopol, and having reached the banks of the Alma, inflicted a sanguinary defeat on the enemy 20th September, made a detour to Balaclava, and when attacked there drove off their assailants, and again successfully defended themselves on the heights of Inkermann. They laid close siege to Sebastopol, and many heroic minor contests illustrated the occurrences of the time. The Sardinians joined the allies, and along with the French—after a severe conflict — occupied the heights of Tchernaya, 16th August. Nicholas I. died 2nd March, 1855, and Alexander II., his son, succeeded. Sebastopol, the great southern naval depot and arsenal of Russia, having endured a siege of 316 days, was at length compelled to capitulate 9th July, 1855. After the signature of the peace of Paris, March 1856, the allied armies evacuated the territories of Russia, the frontiers of which were by treaty removed to a distance from the banks of the Danube. The new czar devoted himself to internal organization and reform. The serfs were emancipated in 1863, a Polish insurrection was crushed, and Poland absolutely incorporated with the empire. The contest in the Caucasus, which had lasted half a century, was brought to a close by the capture of Schamyl (1797–1871) at Ghunib, 1859, and his release after taking the oath of fidelity, 1866. In the Franco-German War of 1870 Russia took no part, but during its progress she repudiated her treaty obligations regarding the neutralization of the Black Sea, gained her object in 1871, and in 1874 entered into alliance with the royal family of Britain by the marriage of the Duke of Edinburgh to the Grand-duchess Marie, Czar Alexander II.'s only daughter. Some smouldering causes of discontent burst out into insurrection against the sultan in Bosnia, Herzegovina, and Servia. The Turks, by murder, massacre, and atrocities, aroused great indignation, and serious fights ensued. Diplomatic negotiations for the securing of the peace of Europe by promoting reforms in Turkey failed, and on 24th April, 1877, Russia declared war, and its armies crossed the Turkish frontiers both in Asia and Europe. Kars was invested 22nd May, and the Danube crossed 30th June. General Gourko seized the Shipka Pass; Plevna was assailed 30th July, but Russia was disastrously repulsed. Aided by Roumania, Russia again invested the place, and at last, 10th December, Osman Pasha was forced to yield. A combined advance was made towards Constantinople, but Britain interposed to save it. In Asia Kars was taken and Erzeroum threatened. Turkey sued for peace, and at San Stefano a treaty was signed. But the signatories of the treaty of Paris revised this, and at the Congress of Berlin lessened Russia's gains in Europe to a strip of Bessarabia. This war prevented Russia's aggressions in Asia for a time, but they were recommenced in 1879. On 13th March, 1881, the Nihilist conspirators against Imperialism, after many attempts, succeeded in murdering the Czar. Alexander III. continued the old policy, and in Asia the aims of Russia and the claims of Britain brought on the jeopardy of war—averted only by diplomatic intervention. Russian intermeddlement was begun once more in Bulgaria, and again diplomacy was taxed to the utmost to prevent a war likely to embroil the Pentarchy. Russian autocracy is the only sovereignty of the sword claiming power in Europe, and it is probable that the restraints imposed upon its interference will necessitate its adoption of the reign of law within, and the co-operative acceptance of the dominion of international jurisprudence without, its immense territorial holdings. Thus, for the time, the western disturber of the balance of power has had opportunity given it of growing great by internal improvement, and the development of patriotism and public spirit.

The stubborn assertion of autocratic supremacy in the East was for a long time counterpoised by the active effervescence of spirit in the West, eager to realize once more Napoleonic Cæsarism in France. Austria, desirous of securing supremacy in Italy, sought to unite to herself, by secret treaties, all the minor states. Cavour realized the danger and resolved to defeat the scheme. The army of Sardinia, glowing with the fame of the Tchernaya, was rapidly increased and diligently drilled. Austria declared this to be a menace and threatened war. Victor Emmanuel II., having given his daughter Clotilde in marriage to Prince Napoleon, cousin of the French emperor, gained, by the cession of Savoy and Nice, the aid of France. When Austrian troops crossed the Ticino, 29th April, 1859, a short but sanguinary campaign followed, illustrated by actions at Montebello and Palestro, 20th and 31st May, Magenta and Solferino, 3rd and 24th June, in each of which the Austrians were defeated; peace was sought and bought by the treaty of Villafranca, at the cost of the cession of Lombardy (minus Venice) to the Sardinian sovereign. Then the Italian co-signatories revolted, and Garibaldi, having headed them, by heroic efforts achieved their deliverance from Francis Joseph's power, and brought them to declare for Victor Emmanuel and a united Italy—the first parliament of which met 1861. The great powers recognized the king and kingdom of Italy 1864. Venice was gained in 1866 and Rome in 1870. Cavour died in 1861, before his heart's desire—a free and united nationalized Italy—was accomplished; Victor Emmanuel, under whom the aspiration of Italians since the days of Dante was realized, died 1878, and Humbert I. succeeded a constitutional sovereign; the noble, simple, patriotic Garibaldi died 1882. Italy has been engaged in war with the Abyssinians in Africa, and Signor Crispi has enteredinto a league of peace with the Southern States along the Mediterranean shore.

Austria's relations with her Hungarian subjects had been strained since Kossuth and his patriotic fellows had been foiled, and during the Russo-Turkish War it was with difficulty the dual empire was preserved from division—each taking different sides. In 1867 its statesmen conciliated

Hungary by having the emperor crowned king at Pesth—under oath to conserve all the old rights of that nation on his part, and on theirs of allegiance to the crown. Except an internal commotion excited by a decree ordaining the German language to be taught in all non-Magyar schools, the two politically federated yet constitutionally independent kingdoms have progressed pretty harmoniously, and though Russian scares occasionally threaten a panic, the renewed commercial relations between Austria and Prussia seem to give hope of stability for some time, although it is not unlikely yet that a Southern Slavonic confederation may be found to be the only sure safeguard of the balance of power in the east of Europe.

The reason for these Austrian concessions to Hungarian aspirations must be sought in the recent relations of the northern and southern Germanic empires. In the peace-year 1851 the German Bund was renewed. Prussia and Austria, having passed through severe political storms, making a virtue of necessity, both declared themselves bent on securing the unity—under constitutional confederation—of Germany. In 1861 Frederick William IV. was succeeded by William I. He had the Hohenzollern tenacity of purpose and dynastic ambition, and aided by his prime minister, Otto von Bismarck, set to work to achieve the regeneration of Germany on the Prussian ideal and through the warlike regimen of blood and iron. The King of Denmark's wrongful claim of Holstein—a strictly German duchy of which he happened to be the chief—as a Danish duchy and an appanage of the Danish crown, being persisted in, led to the breaking up of the National Assembly constituted in 1848 with the universal approval of Germany. The Bund commanded Prussia and Austria to occupy the territories in dispute conjointly till the claims were adjudicated on by the Diet. In 1866, under plea that Austria was encouraging the Augustenberg claimant, Prussia annexed the Holstein-Schleswig duchies and Hesse-Cassel, overran and annexed part of Saxony, entered, conquered, and annexed Hanover, and when Austria remonstrated, by a short, sharp conflict in Bohemia, ending with the battle of Sadowa, 3rd July, 1866—one of the most stubborn, sanguinary, and impressive battles of the century—subdued the Austrians, annexed Frankfort and Nassau, and, by the conditions of the treaty of Prague, succeeded in obtaining supremacy in Germany, the confinement of the political influence of Austria to its Cisleithan and Transleithan territories, and six millions in name of expenses. The confederation of North Germany, the cession of Venice to Italy, and the concession to Hungary of legislative independence, were some of the after-results. Prussia was now the most powerful state in continental Europe, and held the political leadership of a rapidly unifying Germany in its hands. But the heir of the Napoleonic glory—whose destiny was taken to be to humble and punish in succession the adversaries of the first Emperor of the French—having dealt an effective blow to Russia by the success of French arms in the Crimea, and to Austria in the victories of Magenta and Solferino, was in search of a *casus belli* with Prussia. When that is eagerly sought it is generally easily found. Spain wanted a king. Prince Leopold of Hohenzollern was proposed to and accepted by Colonel Prim as precisely the man for Spain. Napoleon III. found in this his longed-for opportunity. He declared that the German candidature must be given up. Prussia professed no concern in the matter, but affirmed the right of Spain to freedom of choice. Realizing the evil of a dynastic war, waged on such a pretext, Britain intervened to promote peace; and while the prince's name was withdrawn by consent, Prussia refrained from countenancing the prince's candidature. Napoleon insisted that Prussia should undertake, that on no account or at any time should that prince's claims be again advanced or promoted. This was political *charlatanerie*; only one answer could be given—an emphatic No! On 15th July, 1870, Napoleon III. declared war. All Germany rose in favour of Prussia. To the emperor's dismay he found that his theatrical trick could only be a flash in the pan. Germany was ready and enthusiastic, France unready and laggard. Besides, Prince Bismarck had shown that while professing enmity to Germany, he had been asking the cession of Belgium as the price for allowing Prussia to deal with Germany as it chose. Napoleon was stricken with mental paralysis. His self-possession forsook him. Instead of an instantaneous activity of movement, he did not arrive at Metz till 28th July, and only on 2nd August he joined Frossard at Saarbrück, and after throwing a few shells into the town, telegraphed that the Prince Imperial had at this siege undergone his "baptism of fire." By that time 500,000 Germans were under arms. On 4th August the French, after fighting well, retreated from Weissenberg; at Wörth, on the 6th, MacMahon was put to utter rout, and, at Forbach, Frossard suffered disastrous defeat. Bazaine began to retreat to Chalons on the 12th; the Germans intercepted them a few miles from Metz. The battles of Courcelles and Vionville took place, and as the great engagement at Gravelotte ended in disaster and defeat, the army of the Rhine rushed within the shelter of the Moselle-washed fortress. After a siege of seventy days it surrendered, and subsequently became the capital of German Lorraine. MacMahon and Napoleon set out to relieve Metz, and they had slowly reached the Meuse when they were encountered, on the 30th, by the German forces; fighting continued for three days, and the 1st September witnessed, near Sedan, the struggle which closed the Napoleonic empire. The emperor, marshals, generals, and an army of 100,000 soldiers made an unconditional surrender. On the 4th a republic was formed and a Government of National Defence took office. By the 19th Paris was invested. M. Jules Favre evoked diplomacy; Gambetta, having escaped from Paris in a balloon, endeavoured to organize an army for the relief of Paris. Many efforts were made by sortie to break the lines of the besiegers, and by the armies of the provinces to reach the begirt city. All failed. Within and without every hope vanished, and after great sufferings Paris capitulated, and at Versailles, 28th January, 1871, temporary terms were signed. Peace was agreed to on 24th February, and ratified by the National Assembly on the 28th. Paris was occupied by 30,000 Germans, as a sign of conquest, for two days; a fifth part of Lorraine, including Metz and Thionville, and of Alsace, with the exception of Belfort, were ceded to the victors, and £200,000,000 was demanded as expenses. Hard as the terms were they were accepted, and yet, almost immediately, resistance was made. Before March closed the Commune had triumphed, and every department of affairs was under the management of speculators in spoliation, enthusiasts in politics, and adventurers in revolution.

The condition of Paris under the Commune was more terrible than it was under the invader. M. Thiers, the chief of the executive, could not for some time restrain the reckless and defiant Communists, who forbade public worship, murdered the Archbishop of Paris, levied blackmail from the rich, quarrelled among themselves, and destroyed the property of the state. At length the troops of the Assembly were brought together and an army was encamped within the city walls. Bloodshed and destruction prevailed, citizens and soldiery fought, public buildings were destroyed by incendiaries, and even private dwellings were set ablaze with petroleum. The excesses of that week of horror thrilled Europe and deprived France of the sympathy which had been felt and shown when the siege of Paris was raised. The expulsion of the Communists in 1871 was followed by the withdrawal of the victors, who gave up the last fortress they held—Vendome—in September, 1873.

In January, 1873, at Chiselhurst, Napoleon III. died. The Prince Imperial, eager to gain the military experience and renown which befitted the traditions of his house, joined the British army in the Zulu War as a volunteer, and was slain in June, 1879. Early in 1883 the Comte de Chambord—whom it was at one time intended to proclaim as Henry V., King of France—also died. Meanwhile M. Thiers and his associates wrought nobly for France. The indemnity money was speedily raised and paid, and things seemed likely to settle down into a condition of quietude when Gambetta made an ultra-republican speech, which excited the fears of the monarchists and led to the retirement of Thiers and the presidency of MacMahon. The National Assembly of 1871 had carried on the government so far boldly, and wisely decreed that their provisional power should cease and a new legislature be elected in March, 1876. In 1879 MacMahon resigned

and M. Grévy was called to the headship of the republic. In 1887 he was, through unpopularity, originating in a traffic in decorations, replaced by M. Carnot, who has, as his predecessors in office have done, maintained order internally and peace abroad. Communist agitation and agitations for a revisal, if not a reversal, of the constitution have been active, but on the whole the prestige and policy of France have been wonderfully restored and maintained.

Germany, which had long desired recognition as a national unity, now saw that the success of Prussia deserved recognition. The States requested William I.'s acceptance of imperial dignity, and on 18th January, 1871, at Versailles, he was proclaimed and crowned, in his seventy-fourth year. Three months afterward the new constitution was settled and signed. Thus as the French Empire vanished from the political stage, the Empire of Germany acquired historical existence. The main endeavour of the German government has been to consolidate and organize with a marvellous completeness the diverse elements of the empire into a well-knit union, and, while holding strict watch over the course of politics, to keep free from embarrassments of a merely temporary sort, and endeavour to preserve, not disturb, the peace of Europe. With this view an army bill was—though only after a dissolution of the Reichstag—passed, and a treaty between Germany, Italy, and Austria has been concluded with the design of bringing the whole of Central Europe into a confederation which shall restrain any attempted encroachment, whether from east or west.

We have mentioned that the ostensible cause of the Franco-German War was that Prince Leopold of Hohenzollern had been suggested as a suitable sovereign for Spain. After the death of Ferdinand VII., in 1833, civil war was carried on between the adherents of his daughter Isabella—in whose interests the Salic law had been repealed—and the partisans of his brother Don Carlos, who held that the throne was hereditary in the male line alone. In 1834 the European powers acknowledged Isabella II. The queen-mother, Christina, in her behalf granted Spain a new constitution in 1837, which was modified in 1845, suspended in 1857, restored in 1864, but so little regarded that in 1868 a revolution arose and a new dynasty was proposed. After the failure of many negotiations and the occurrence of the Franco-German War, King Amadeus I., duke of Aosta, was chosen, but finding his rule only tolerated by one party and used as an occasion for factious insurrections, he resigned in 1873. A republic was proclaimed, but the mutual strife of the factious led to the accession of Isabella's son in 1875, as Alfonso XII. Carlist insurrections continued for a year. Isabella was permitted to return. Alfonso married, first the daughter of the Duke of Montpensier, January, 1878, and after her death in June, the Archduchess Christina of Austria, November 29, 1879. He died November 25, 1885, and a posthumous son, born 17th May, 1886, was proclaimed King Alfonso XIII., with his mother as regent. Besides her home strifes Spain has had difficulties abroad. In 1860 she declared war against Morocco, seizing the seaport of Tetuan; in 1861 part of San Domingo was taken; and for a time the armed intervention of France in Mexico was aided by Spain. Against the republic of Peru she declared war in 1864, and over Chili, which had become independent in 1818, after the battle of Maypu, she reclaimed a protectorate, and bombarded Valparaiso in 1866. In this she was successfully resisted. Chili and Peru had subsequently a dispute between themselves, which broke out into war in 1879. The Chilians vanquished the Peruvians by land and sea, captured their capital, Lima, and when, in 1883, terms of peace were settled, the far-west South American continent acquired a large accession of territory from the land of the Incas. Of late the possibilities of Morocco seem to have excited great expectations in Spain, and not only has an expeditionary corps been established, but earnest anxiety is felt to press on the strengthening of the navy. Numerous factions still wrangle among themselves, but the majority profess attachment to monarchy, favour for constitutional principles, and aversion to revolutionary movements.

Portugal, after a long period of invasion, political anarchy, and contests for the crown, was more fortunate than the sister country of the Peninsula. At the death of Maria, who, after a sanguinary civil war waged by her uncle Dom Miguel, was restored in 1833, and left her crown to her son Pedro V., under the regency of his father (1853), the little western strip of Europe appeared to prosper well. In 1861, however, Pedro died, Dom Luis succeeded, and by a marriage with the daughter of Victor Emmanuel of Italy, strengthened his dynastic influence; while more recently his eldest son, by marrying the Princess Amelia of Orleans, daughter of the Comte de Paris, has acquired relations with the monarchists of France. The constitution has been modified, with increasing leanings to limitation of sovereign power and a responsible ministry, in 1852, 1864, and 1878. When Brazil acquired its independence in 1825, it became a constitutional empire under Dom Pedro, the son of John VI. On John's accession to the crown of Portugal, he resigned both thrones, giving Portugal to Maria and Brazil to Dom Pedro. Since that time Portugal has been once more a European power governed not from Brazil, but from within, and Brazil, free to pursue South American influences alone, has been making steady progress, and in 1885 decided to emancipate its slaves.

The United States of North America did not accomplish the freedom of their slaves peacefully. These vast territories have been the scene of singular changes and of unprecedented advancement. New states have been formed to the west, and their sway now extends from ocean to ocean. Owing to disputes about the boundaries of Texas—which, after a war of separation, closed by the battle of San Jacinto, had been acknowledged as an independent state, and had been admitted to the Union in 1846—war was declared by the States against Mexico. In this two battles were gained and the city of Mexico was taken by the States. By treaty, New California and New Mexico were ceded to the United States and their boundaries settled in 1848, though somewhat modified in 1850. Mexico fell into anarchy under Juarez, an armed intervention was undertaken to establish law and order, an empire was resolved on, and the Austrian Archduke Maximilian, in 1864, accepted the crown. The States resented this intrusion of France into territory so nearly adjoining theirs, and at their demand the French troops evacuated Mexico in 1866. Unpropped by French bayonets, Maximilian's throne collapsed; he was betrayed and shot 19th June, 1867. Juarez resumed power, and on his death in 1872 Lerdo de Tejada was made president of the republic. Under him there was less disorder and considerable progress. In 1884 General Porficio Diaz succeeded, and after eighteen years' suspension, diplomatic relations between Great Britain and Mexico were, in 1885, re-established under his rule. The country is gradually settling down under a constitutional and compact ministerial government. After a twelve years' union, Texas passed, on 11th June, 1861, an Act of Secession from the United States, having joined the cause of the Confederate States, which, consequent on the election of Abraham Lincoln as president of the United States in November, 1860, had resolved to withdraw from the Union. The chief cause of this political disruption—the greatest event in the history of the republic—was slavery. A critical juncture had arisen in which that mighty federation, which had so nobly maintained the rights of man, was called upon to decide whether negro slavery might be extended from the Potomac to Cape Horn, or should be declared an illegal and impossible thing within the limits of the American free states. Fortunately, for the credit of humanity and the future of the world, the republic prevented the calamity and avoided the disgrace. Abolitionism triumphed and freedom prevailed—but not till, by a fearful fratricidal war, the American democracy had been tried, as by fire, and regenerated the policy of the states whose constitution declares, as its first principle, that "all men are free and equal." On 4th February, 1861, delegates met from the seceding states and organized the Confederate States of America, having Jefferson Davis of Mississippi, and A. H. Stephens of Georgia, as president and vice-president respectively, with the seat of government at Richmond (24th May). Senators and representatives gave up their seats in Congress; officers of the army and navy resigned their commissions and devoted their services and swords to the Confederacy. Fort Sumter, in Charleston harbour, was besieged. A Federal naval expedi-

tion for its relief set sail. On its arrival within sight the Confederates began a bombardment, and on the 11th April the fort surrendered. Immediately 75,000 Federal volunteers enrolled for the defence of Washington, and they were confronted at Bull's Run, on the Potomac, by the Confederates. A panic seized the Federals, who retreated to Washington. Half a million men were called out by Lincoln; the whole coast-line from Virginia to Texas was blockaded, while the Confederates fortified the rivers Tennessee, Cumberland, and the Lower Mississippi. Nashville was taken 6th February, 1862, and held by the Federals; Roanoke Island was captured, and Yorktown was successfully assailed; but after fighting his way towards Richmond, M'Clellan was driven back to the gunboats after six days' sanguinary conflict, and in the Shenandoah Valley "Stonewall" Jackson defeated Banks and Pope, who were to have supported the attack on Richmond. Another defeat was inflicted on the Federal forces at Bull's Run. M'Clellan and Lee met at Antietam. The result was a drawn battle. Lee next appeared before the army of the Potomac at Fredericksburg, and vanquished General Burnside there in one of the bloodiest battles of the conflict. Several engagements took place with heavy loss to both parties, but with no decided victory till early in May, 1863. Lee defeated Hooker at Chancellorsville—Jackson being by mistake mortally wounded by his own men. Taking now the offensive, Lee advanced to Harrisburg, and attacked General Meade at Gettysburg unsuccessfully, and was soon driven again beyond the Potomac. The Federal forces besieged Vicksburg and Port Hudson, starved them into surrender, and opened the Mississippi. Rosencranz, having taken Chattanooga, pushed into Georgia, and suffered defeat by General Bragg at Chickamauga. Riots ensued, cries for peace arose, conscription was disliked, the declaration of the freedom of the negroes was unpopular, and credit depreciated. The Federal government had command of the sea and access to the market, while the Confederates were land-locked and exhausted. Ulysses S. Grant, in 1864, became commander-in-chief, and planned a coursing campaign over the Southern States with 1,000,000 men. In this series of strong, grim, retaliatory measures, the Federalists endured terrible losses, but kept doggedly on, always making further progress within the enemy's territories. At length, in 1865, the very citadel of the Confederates was put under assault. On 2nd April Richmond and Petersburg were surrendered. Lee capitulated on the 9th, and on the 12th Mobile was taken. In the midst of these warlike proceedings, the poll for the presidency was taken, and Lincoln was once more placed at the head of affairs. News of the surrender of the Confederate army had just brought animation and joy to the North, when, on the 14th of April, John Wilkes Booth assassinated the president, and was himself pursued and slain. Andrew Johnson, advanced to the presidency, was able to declare the war ended, to proclaim the perpetual abolition of slavery in the States and territories of the republic, to restore the seceded states to their place in the federation, and to announce the pardon of most of those who had taken a prominent part in the rebellious secession. During his tenure of office, the republican party, even against his veto, passed their legislative measures. In 1869 General U. S. Grant was elected, and in 1873 re-elected. Under him the *Alabama* claims were pressed. It was urged that the British government, as a neutral power, failed in its duty to prevent the building and fitting up of cruisers in favour of the Confederates in its ports, and compensation both for direct and indirect damages were sent in. Britain declined to admit indirect claims as merely inferential and incapable of being sustained or rebutted by trustworthy evidence. The arbitrators disallowed these, and ultimately awarded £3,000,000 for direct claims. The award was at once paid and the dispute terminated. General Garfield, elected in 1880, took office 4th March, 1881, and on 2nd July was shot by Charles Guiteau, a place-hunter he had displeased. On his death—which was the occasion of universal mourning—Mr. Arthur stepped into the highest position in the state, and managed to leave it unmarked by any striking achievement. Mr. Groves Cleveland, elected in 1884, in his first message to Congress, 1885, commended the condition of the British and American fisheries to consideration. Almost the only domestic difficulty with which Mr. Cleveland has had to deal is the development of communistic anarchism, the interference of the Knights of Labour with industrial enterprise, the wise disposal of accumulating surplus revenues, and the judicious rearrangement of fiscal measures and tariffs.

While the freedom of the negro race has been thus almost entirely effected in the western hemisphere, the home-land of the slave has been gradually undergoing partition among several of the European powers. France has given to her colonies proper, and "pays protégés" in Africa, the right of representation in Senate and Chamber; Portugal is cultivating somewhat more carefully her hitherto neglected dependencies; Italy is seeking territorial extension along the margin of the Red Sea; Spain is eager to conquer Africa's northern coast; a German West African Society has acquired and is exercising, under government sanction, sovereign rights over Luderlitz, Namaqualand, and Damara; the Congo River Free State, as a sovereign power, whose status is acknowledged by the Great Empires of Europe, has been formed by the International Association of the Congo, with the King of Belgium as patron, to train and elevate the industrial powers and intellectual capabilities of the inhabitants of the Dark Continent, so as to realize true manliness and good citizenship. With perhaps even higher aims the church missionaries in Central Africa are engaged in the moral civilization of the people and the commercial development of the mighty lake districts and inland seas that lie in the hollow of subtropical lands. Besides the many colonial possessions of Britain to which civilization has been carried by immigrants, and numerous stations established for the prevention of the slave trade and the protection and promotion of commerce, both British and German East African associations have been constituted, which have power granted them to exercise generally all governmental functions—such as to raise and maintain competent military and police forces, to equip ships, erect forts, fix and enforce civil and criminal law, levy customs and taxes, open up commercial routes, and to employ and perform all the executive acts which devolve upon sovereign states, under the condition that all that is done under their respective flags shall be in accordance with the terms of the concessions granted to them, and have for their aim the civilization of Africa. Though many of the most famous of the explorers of Africa who have lost fortune, health, and life for the spread of real civilization within its borders have been British born, the political relations of Britain and Africa have not, of late years, been altogether satisfactory. Theodore, king of Abyssinia, incensed at the British consul for visiting some provinces under Egypt's sway, imprisoned Captain Cameron and others, and refused to set them free. An expedition, under Sir Robert Napier, landed at Annesley Bay on the Red Sea shore, marched towards the rock-fortress of Magdala, and demanded the release of the captives. Theodore was obdurate; Magdala was stormed, and in despair the king shot himself, 12th April, 1868. The captives were liberated without the loss of a single British soldier, but the Abyssinians had 500 killed alone. Acting with Britain in the Soudanese War the Abyssinian troops defeated Osman Digma's forces at Kufeit, 23rd September, 1885. For a time the Ashantee dominions were disparted into small states—Tigré, Amhara, Shoa, &c.—but under Johannes II. (*Kassa*) these have been reconstructed as an empire, as sovereign of which he was crowned, 1872. While Colonel Hill was governor, in 1853, at Cape Coast Castle, an Ashantee army 20,000 strong invaded British territory without warning. The governor called together such help as he could, and peremptorily insisted on its recrossing the Prah in twenty-four hours. The army retreated, and not again till 1862 did any notable difficulty arise. Then there was a plundering raid sent through the protectorate. Colonel Pine cleared the country, and for other ten years a sort of sulky intercourse was maintained. Britain's acceptance of the Dutch territories in 1873 brought the Ashantees, 50,000 strong, swarming across the Prah. This led to Sir Garnet Wolseley's expedition. The battle of Abrakrampu was fought 7th November, and the enemy retired. Throughout January, 1874, fighting was frequent, as the British pressed on to

Coomassie, which was taken on the 4th and destroyed on the 6th February. The king sought peace on any terms. On the accession of Cetewayo as king of the Zulus in 1872, he organized an army, threatened Natal, and so got embroiled with the colonial government. Refusing to disarm and disband these forces, the British troops in 1879 entered Zululand. Those in the south commanded by Colonel Pearson, though he defeated his opponents, were besieged in Ekowe for months. In the north, Sir Evelyn Wood, after suffering several reverses, was victor at Kambula Kop. The centre, under Lord Chelmsford, was surprised and 1000 British slaughtered at Isandula—the Prince Imperial of France was slain—and Chelmsford retreated from Rorke's drift. The Zulus were thoroughly defeated at Ulundi, Cetewayo captured, and his territory divided into thirteen chieftaincies. Disorder soon ensued; Cetewayo was restored under British protection; but being defeated by Usibepu he fled to British territory and died 1882. The Dutch agricultural colonists of the Transvaal, who felt aggrieved by its annexation in 1877, rose against the British in 1880. In 1881, under treaty, the management of internal affairs was conferred on the Boers, while external relations were retained in the hands of Britain. The South African Republic was recognized in 1884; but many of the discontented traversed the Transvaal boundaries, took possession of tracts in Zululand, and instituted a new republic. Zululand was annexed by Britain in 1887. Its chiefs having sought help from the Boers against the British, hostilities ensued, and the district has become a source of trouble.

Egypt, while nominally a province of the Turkish empire, is also a sovereign state, ruled by a Khedive, whose title was fixed in 1867. Owing to the unsatisfactory state of its financial affairs, a joint control exercised by France and England was established in 1878. Arabi, the chief military officer, organized a revolt, the watchword of which was "Egypt for the Egyptians." The Khedive was unable to subdue it, and England intervened. While British forces were engaged in its suppression, Mohammed Ahmed, proclaiming himself a Mahdi (*Deliverer*), headed a revolution in the Soudan, and gave (1881–85) the Khedive and the British much trouble. Arabi, who had set fire to Alexandria, was, after several minor skirmishes, confronted by Sir Garnet Wolseley at Tel-el-Kebir, and in a hot engagement defeated. He fled to Cairo, where he was captured, and whence he was deported to Ceylon. Wolseley returned; Sir Evelyn Wood, to whom the Egyptian troops had surrendered, remained to support the Khedive, reorganize military discipline, and educate Egypt to self-government. The Mahdi's forces had succeeded in surrounding and destroying the Egyptian army in the Soudan in November, 1883. The defeat of the Khedive's gendarmerie at Teb exposed Khartoum and Alexandria to probable massacre. Sir Gerald Graham was hastily ordered to do his best to save the Tokar garrison from starvation and massacre, which that at Sinkat had undergone. In the face of great dangers he succeeded. Other serious encounters took place. General Gordon, who had acted as Governor of the Soudan, 1877–80, summoned from Brussels, whence he was about to proceed to the Congo, volunteered to relieve the endangered garrisons, and set off at once to Khartoum. Shortly after his arrival there it was invested, and before Lord Wolseley could carry assistance thither Gordon died, nobly doing his duty—the victim of treachery—26th January, 1885. In July following the Mahdi died; but a rival Mahdi had appeared, and fresh complications arose. The Khedive's rule has been confined to the lower valley of the Nile, the territory of the upper valley having been separated from the lands of the Khedive. Occasional disturbances still require military interference to keep order both on the Soudan frontiers and in Egypt. The Khedive has consented to the abolition of the Corvée (*i.e.* forced labour), and the neutralization of the Suez Canal—the other powers assenting. Diplomacy is engaged on the vexed question of self-rule for Egypt in subordination to the suzerainty of Turkey.

Turkey has indeed had troublous times of it in modern history. We have already noted the chief events of the Crimean War, under Abdul Medjid, in opposition to Czar Nicholas' claim to a protectorate over the Greek Christians in Turkey. Abdul Aziz succeeded in 1861. Revolts in Herzegovina and insurrectionary tumults in Crete, after a lengthy and sanguinary struggle, were suppressed in 1868. In 1869 the Sultan visited the west, and was honourably entertained in France and Britain. His exactions again excited Herzegovina to rebellion. This drew forth the "Andrassy Note," pointing out to the Porte the reforms deemed necessary by the Powers to pacify the empire. In May, 1876, the Sultan was deposed and committed suicide. His successor, Murad V., proving of unsound mind, was replaced by Abdul Hamid II. Servia and Montenegro, under Russian inspiration, declared war against Turkey in favour of the Bosnians and Herzegovinians, and their army, under General Tchernayoff, crossed the frontiers. Turkey forced him to retreat, and gaining victory after victory, showed wonderful power in arms. But it had tarnished its fame by the Bulgarian atrocities, and the sympathies of Europe were alienated. By the Berlin Memorandum and the conference at Constantinople the powers endeavoured to bring Turkey into concord with European civilization; but she would not listen, and Russia, 24th April, 1879, issued an ultimatum, compliance with which Turkey refused. The Russian forces at once crossed the frontiers in Europe and Asia. After a severe struggle the Turks sued for peace. Roumania, Servia, and Montenegro were declared independent kingdoms, and Bulgaria was constituted an antonomous tributary principality. Both threats and blandishments have been employed by Russia to gain over the Sobranje (*i.e.* National Assembly) to her aims, and German, Austrian, Russian, and British diplomacy have before them the task of settling the crown and throne of these distracted territories.

Great Britain, though it has since the fierce warfare of Waterloo been gradually disengaging itself from the territorial complications of European politics, has very properly retained the position it gained as one of the sovereign states by whose arbitrament the balance of power on the Continent is regulated. Only on extreme occasions has it been necessary for Britain to act otherwise than as diplomatic counsellor, trusted umpire, and acknowledged impartial interpreter of the equities of international law in the inevitable changes of states in the lapse of time and the restless vicissitudes of circumstance. Only twice has armed intervention been requisite on her part since Napoleon's death in St. Helena. In the one case the naval annals of Britain were illustrated by Admiral Codrington's victory at Navarino, 1827, and in the other there have been written on the roll of fame the names of Alma, Balaclava, Inkermann, and Sebastopol. Her flag has waved proudly in the Mediterranean and the Baltic. In only a few cases has even a military or naval movement been made in relation to the territorial management of international concerns: although in Greece, in Spain, and in Italy volunteers have gone forth from her borders animated by heroic instincts and love of liberty to aid oppressed nationalities in their endeavour to secure constitutional rights and rational freedom. She has been sometimes stigmatized on the Continent as "insular," and been disparagingly regarded as "a nation of shopkeepers;" but the insularity of her situation has been found of immense advantage to her as a political power not readily disturbed by threats, and not easily imperilled in her possessions by those who are dissatisfied by her decisions. She has, however immersed in trade and engrossed with commerce, always held high aims before her as to freedom and equity at home and abroad, and has neither bartered nor sold her counsel nor her sword for territorial aggrandizement or mercantile privilege. Most usually Britain has undertaken considerable burden of costs for the promotion of peace in the world, and the preservation of law and order in every quarter of the globe.

Possessing as she does an empire "on which the sun never sets," open to every sea and surrounded by neighbouring states in all conditions of national and political development, it is not to be wondered at that both her army and navy have been active. With China, owing to the maltreatment of the crew of the lorcha *Arrow*, 8th October, 1856, and the refusal of reparation, Canton was stormed, Commissioner Yeh captured, and the forts of the Peiho taken. On 26th January, 1858, by the treaty of Tientsin, the relations between Britain and China were reconstituted, but owing to China's treach-

erous dealing, the Taku forts and Pekin were taken. By the treaty of Pekin twenty-two treaty ports were opened to the commerce of all nations. The British occupation of Wei-hai-wei in 1898 was rendered necessary by the Russian occupation of Port Arthur as one of the termini of the trans-Siberian railway, and by the German occupation of Kiao-chou, both of which movements resulted from the defeat of China in the war with Japan of 1894, and the consequent intervention of France, Germany, and Russia. At the close of the second Burmese War, 1852, a large portion of the coast-line became British. In the third war Upper Burma was annexed, 1886.

After the annexation of Oude, 1856, and as a result of the mutiny of the Sepoy army (1857–58), involving the siege of Delhi, the massacre of Cawnpore and its punishment, two sieges of Lucknow, the battles of Agra and Gwalior, &c., the East India Company, as a branch of the government of India under the crown, ceased to exist, 1st September, 1858—the direct exercise of sovereignty being vested by Parliament in the crown. In 1876 Queen Victoria was recognized as Empress of India. Of late the external relations of India have attracted much attention. The northern boundary of Afghanistan has been, in harmony with Russia, carefully settled—the *durbars* of the viceroys have been attended by many foreign chieftains who have not previously acknowledged even a moral allegiance to Britain—the defence of the Indian frontier has been favourably aided by the native princes—Indian delegates from the three presidencies have made their grievances known to the British public—and the National Indian Congress, in its annual meetings, is steadily but peacefully pressing for a larger employment of natives in the higher departments of the administrative service and the gradual introduction of representation into the legislative assemblies. Modern politicians look hopefully upon the rapid progress made in education in India, and believe that the intelligent interest shown by its best minds in morals, economics, and politics leaves little doubt that measures of constitutional freedom may be speedily introduced.

Meantime at home Britain has been engaged in making wise and thoughtful political progress. The Removal of Jewish Disabilities Bill closed a long sectarian struggle, and the abolition of the property qualification for members of Parliament was granted in 1858. The repeal of "the taxes on knowledge"—the stamp duty on newspapers, 1855, and the paper duty, 1861—has greatly increased the number of newspapers and promoted the cheapness of books. Reforms have taken place in the customs system and in the finance of the government generally, which have led to many beneficial developments of trade and commerce. The adoption of the non-intervention policy—in the modified form of non-intermeddlement with the national and constitutional internal changes of states, unless they involve a breach of international law or threaten the solidarity of political connections—has given a more peaceful external life to Britain and afforded greater opportunities for commercial progress. There had been much need for this; the Chinese disturbances, the cotton famine, financial panics and failures (even to the extent of requiring the suspension of the bank charter), and political agitations had seriously injured trade. The several small parliamentary reforms made from 1853 to 1866 were eclipsed by the Franchise Bills of 1867 for England, 1868 for Scotland and Ireland, the passing of the Ballot Act in 1872, and the Franchise and Redistribution Bills of 1884–85, which raised the electorate of Great Britain and Ireland to 5,000,000 under a "household" suffrage, safeguarded indirectly by the provision made, through the Education Acts of 1870, &c., for the gradual progress of the people in intelligent appreciation of the political principles by which states thrive, and of the problems requiring solution by parliamentary enactment, and more directly by a Corrupt and Illegal Practices Act passed in 1883. The great increase in the representation gave an impetus to Irish riot and agitation. The Fenian movement, originating in 1865 among Irish Americans who had taken part in the Secession War, occasioned great trouble. Endeavouring to remove some discontent, the Irish Episcopal Church was disestablished in 1869, a Land Bill instituting a tenant-right became law in 1870, and subsequent extensions of this form of legislation were made in 1881. Notwithstanding these and many other bills passed by Parliament, either to secure or enforce peaceable progress in Ireland, the continued agitation, supported by some of the most eminent among British politicians, for a separate and quasi-independent government in Ireland has much disturbed the political and social conditions of the three kingdoms; the usual relations of political parties to the people and to the administrative and executive government have been changed; and for the present what may be regarded as a general demoralization of the old ideal of government by party has supervened, the division of opinion on the subject of the unity of the three kingdoms often obliterating older political distinctions. Without doubt the moderation and wisdom of the British Parliament and people will succeed in closing this chronic state of crisis, by applying some measures under which the desire for local control of local affairs will be met without compromising that degree of unity of government found necessary for the security of the United Kingdom, which will thus remain the bulwark of freedom and the upholder of every sound cause having for its aim genuine liberty, humanity, and righteousness.

A general survey of the course of civilization, as exhibited in history, shows a growing desire in all lands to know "what makes a nation happy and keeps it so," a more earnest endeavour to secure and preserve the autonomy of states, and a more distinct recognition of race, language, and sympathies as the bonds of communities and commonwealths. While citizenship is regarded as involving reciprocal rights and duties, statecraft is more and more engaged in welding the world into a permanent unity of associated sovereignties, each of which, while it watches, controls, and arranges all its own internal affairs according to its own laws, customs, and traditions, has a right to integrity of territory, condition, and existence, free from any external attack or deforcement, so long as it does not disturb the settled forms of life, property, and progress in other states. A state has a right not only to be, but to be what it chooses, so long as its right to be so is maintained and exercised with due respect to the same right in others. International law, whether exhibited in treaties or collected from tradition, defines the positive duties of states as a just and impartial avoidance of any infringement of the integrity of one another, and the final teaching of history seems to be that that state which secures the largest amount of wisely ordered freedom to the individual is that which possesses the mightiest dynamic force in war, the steadiest static power in peace.

GEOGRAPHY.—CHAPTER XVIII.

SECTION I.—FRANCE.

France is the most westerly state on the maritime border of Central Europe. Boundaries—N. Belgium and English Channel, separating it from England; W. Atlantic; S. Pyrenees and Gulf of Lyons; E. a line passing from Mentone westward to Cannes, up the High Alps to Thonon, round Lake of Geneva, by Jura to the centre of the Vosges, and along by Lunéville, Nancy, Mézières, Givet, and Lille to Dunkirk — a circuit of 3000 miles. It is divided into eighty-six departments, including the Island of Corsica. These may be conveniently arranged in the following four groups, each department being in small capitals, the prefecture following in Italics, and the subprefectures numbered in order thereafter

I. On the north-east slope, comprising part of the basins of the Scheldt and of the Meuse, though only a small portion of each of these rivers belongs to France.

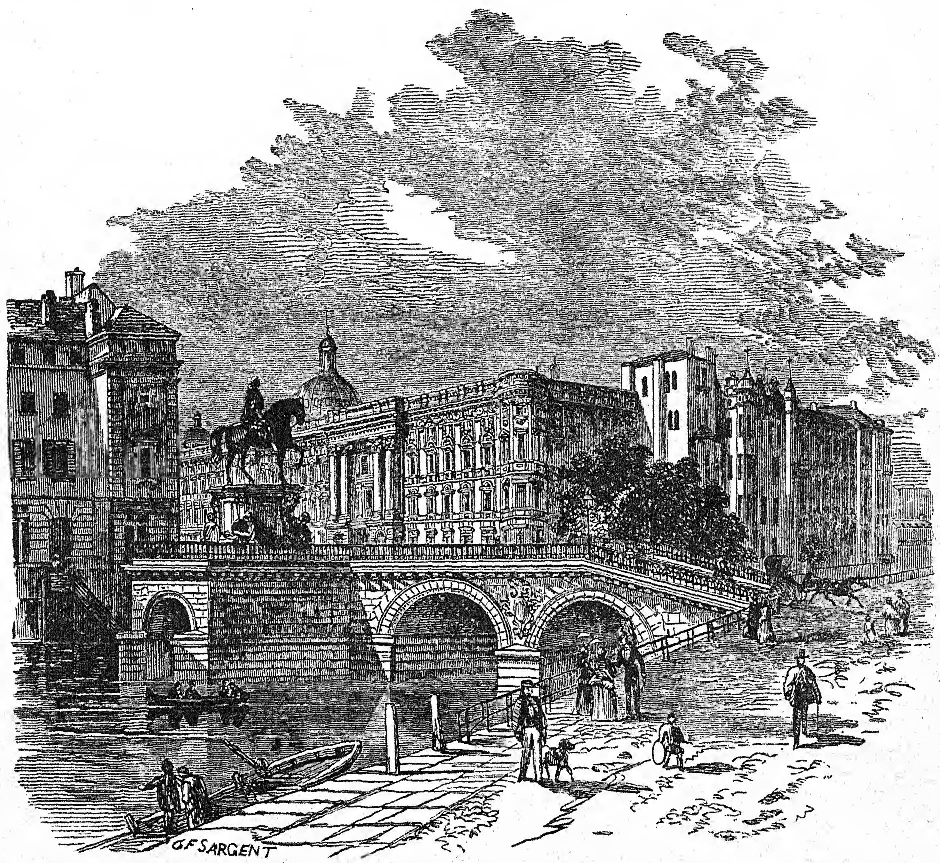
Meurthe and Moselle—consisting of a union of the remaining portions of these departments not ceded to Germany in 1871: *Nancy*, 221 miles east of Paris, handsome town with citadel still preserved—captured by Charles the Bold, 1475, and by Louis XIII., 1634—choice embroidered muslins, hats, hoisery, lace, chemicals—school of medicine; (1) Lunéville, at junction of Vezouse and Meurthe, 180 miles east of Paris—cavalry barracks, woollens, yarn, hosiery, lace, gloves, &c.—treaty 9th February, 1801, fixed Rhine as boundary between France and Germany; (2) Toul, on the Moselle, 13 miles

man terms of peace accepted, 28th February, 1871; (1) Libourne, at junction of the Dordogne with the Isle, river port with active trade and varied industries; (2) Blaye, seaport and fortress on the Gironde, shipbuilding; (3) Lesparre, agricultural produce; (4) La Réole, antique town, ruins of pagan temple; (5) Bazas, on the Beauve, druggets, glass, tan-works. 50. Cantal. *Aurillac*, in picturesque valley of the Jourdanne, birthplace of Sylvester II.; (1) St. Flour, on a steep (almost inaccessible) rock near the Auzon, birthplace of Desaix (1768–1800); (2) Murat; (3) Mauriac. 51. Correze. *Tulle*, cotton-mills and gun factory; (1) Brive, coal mines; (2) Ussel. 52. Dordogne. *Perigueux*, on the Isle, cathedral in form of a Greek cross—bombazine, hosiery, hats—birthplace of Montaigne (1533–92) and Fênélon (1651–84); (1) Nontron; (2) Ribèrac; (3) Bergerac, trade (mainly with Bordeaux) in grain, white wine, truffles, &c.; (4) Sarlat. 53. Ariege. *Foix*, 404 miles south of Paris, old castle, church and abbey of St. Volusien—ironmongery, leather, hosiery; (1) Pamiers, 939 feet above sea-level, chalybeate spring, hardware, woollens; (2) St. Girons, 1276 feet above sea-level, ten great yearly fairs. 54. Tarn. *Albi*—from which the Albigenses (who were condemned 1176) got their name—cathedral of St. Cécile (1282–1512), iron and copper works, bullet foundries; (1) Castres, in a rich valley on the Agout—cashmeres, silks; (2) Lavour, silks; (3) Gaillac, hats and leather, red wine. 55. Lozere. *Mende*, 2436 feet above sea-level, coarse woollens and paper; (1) Marvejols, on the Cologne, leather, bricks, orchards; (2) Florac, 1960 feet above sea-level. 56. Aveyron. *Rodez*, fine Gothic cathedral, trade in cheese, mules, and cattle; (1) Villefranche, 28 miles west of Rodez, linen factories, copper and iron foundries, trade in bacon, cattle, and truffles; (2) Espalian; (3) Milhau, in a rich dale, broadcloth, gloves, leather; (4) St. Affrique, swanskin and blankets. 57. Lot. *Cahors*, on an escarped peninsular rock, dark red wine—birthplace of Marot; (1) Figeac, amid woods, vineyards, and orchards; (2) Gourdon, 22 miles north of Figeac, woollen stuffs and hats. 58. Gers. *Auch*, Armagnac brandy, turquoise-mine, worsted, velvets; (1) Condom, on a hill above the Baise, trade in grain, wine, and brandy; (2) Lectoure, on an isolated rock, birthplace of Marshal Lannes (1769–1809); (3) Lombez; and (4) Mirande. 59. Hautes-Pyrenees. *Tarbes*, tanneries, foundries, paper-mills, large markets; (1) Bagnères (-de-Bigorre), mineral springs; (2) Argèles. 60. Basses-Pyrenees. *Pau*, on the Gave, old castle—birthplace of Henri IV. (1553–1610) and Bernadotte (1764–1844); (1) Bayonne, at junction of Adour and Nice, 430 miles S.S.W. of Paris, safe harbour, fortified handsome town—entrepôt for all sorts of stores: 5 miles south-west is Biarritz bathing-place; (2) Orthez, woollens, copper-wares—Wellington defeated Soult, 1814; (3) Oleron St. Marie; (4) Mauléon. 61. Landes. *Mont-de-Marsan*, small thriving town on the Midouze, 65 miles south of Bordeaux and north-east of Bayonne, between which it is an entrepôt; (1) Dax, strong castle, Roman ramparts and fosses, hot mineral springs; (2) St. Sever, Benedictine abbey, founded 993—fine pottery, marble, plaster of Paris.

IV. Departments having their slope towards the Mediterranean.

62. Pyrenees-Orientales. *Perpignan*, at the junction of the Basse with the Tet, 525 miles south of Paris, former capital of Rousillon, taken by Louis XI., 1474, and by Louis XIII., 1642—broadcloths, playing cards, hats, leather, brandy, soap, corks, &c.; (1) Prades; (2) Cirét. 63. Aude. *Carcassonne* (the *Carcaso* of Cæsar, Tacitus, and Pliny), near the Canal du Sud, ceded to France, 1247—St. Nazaire (1096) contains monument to Simon de Montfort—fine broadcloth, covered markets; (1) Castelnaudary, 21 miles west of Carcassonne, canal-boats, pottery, bricks—trade in timber, iron, and hides—captured by Black Prince (1355), defeat of Gaston d'Orleans (1632); (2) Narbonne, on the Robine Canal, one of the oldest cities in France, founded by Romans (B.C. 112)—in Cathedral St. Just (1272) Philip III. is buried—industrial products and trade varied; (3) Limoux, mart for iron, broadcloth, tan-yards, soaps, oils. 64. Herault. *Montpellier*, considerable trade, many industries, noted school of medicine, attractive health resort; (1) Beziers, 46 miles south-west of Montpellier, above the Orb and the Canal du Midi, Roman remains, massacre of Albigenses (1209)—active commerce, chemical products, &c.; (2) Lodève, on the Ergue and the Salondres, 32 miles north-west of Montpellier, centre of woollen cloth manufactures; (3) St. Pons (-de-Thomiers), on the Jaur, houses mostly built of marble—corn, fulling and saw mills, dyeworks, &c. 65. Ain. *Bourg* (-en-Bresse), on the Reyssouse, united to France 1601—trade in agricultural products—birthplace of Vaugelas (1585–1650) and Lalande (1732–1827); (1) Nantua, 20 miles east of Bourg, on Lake Nantua, in a wild narrow gorge—watch and clock works, muslins, calicoes, cashmere shawls, trade in fish, cheese, shoes—in its vicinity are the asphalt workings of Seyssel, &c.; (2) Belley, silkworms reared, lithographic stones quarried—annexed 1601; (3) Gex, on eastern slope of Jura—iron foundries, tanyards, &c., 6 miles south-east of Ferney, where Voltaire for twenty years resided and introduced watch-making. 66. Rhone. *Lyons*, at confluence of Rhone and Saone—316 miles S.S.E. of Paris, second city in France, most advantageously situated for commerce and industry, of both of which it is a great centre—councils of the church were held in 1245, 1274, &c.—besieged by the Convention 1793, capitulated to Austria, 1814—unequalled silkstuffs, multifarious commerce; (1) Villefranche (-sur-Saone), 17 miles N.N.W. of Lyons, capital of Old Beaujolais—cottons, linens, &c. 67. Ardeche. *Privas*, on a hill, 1058 feet, between the Ouvèze and the Mezayan—silk-throwing, cattle fairs, markets for farm produce; (1) Tournon, fine suspension bridge, Hermitage wines; (2) L'Argentière, volcanic grottoes, silk-tissues, wine, and cattle. 68. Gard. *Nîmes*, 30 miles north-east of Montpellier, yielded to Rome B.C. 119—striking Roman memorials—railway, manufacturing and industrial centre mart for raw silk; (1) Alais, 30 miles N.N.W. of Nîmes, centre of coalfields, ironworks, raw and dressed silk, cold mineral springs; (2) Uzes; (3) Le Vigan. 69. Haute Savoie. *Annecy*, at north-west of lake of same name, 9 by 3 miles in area, 1500 feet above sea-level, 21 miles south of Geneva—glass, printed cottons, chemicals; (1) Thonon; (2) Bonneville, on the Arve, 15 miles E.S.E. of Geneva; (3) St. Julien. The valley of Chamouni, in this department, is 40 miles east of Geneva, and 3400 feet above sea-level. 70. Savoy. *Chambéry*, 46 miles S.S.W. of Geneva, taken by the French 1702, restored 1815, annexed 1861: 7 miles west is Aix-les-Bains, on the east shore of Lake Bourget, hot sulphuretted springs and baths; (1) Albertville; (2) Moutier (-de-Tarantaise); (3) St. Jean (-de-Maurienne). 71. Isere. *Grenoble*, one of the strongest fortresses and garrison-towns in France—manufactures, kid gloves, trade in iron, marble, wood, liqueurs, leather, hemp, &c.—Roman remains; (1) Vienne, 50 miles north-west of Grenoble, at junction of the Gere with the Rhone—old square tower of Mauconseil, from which Pontius Pilate is said to have thrown himself into the Rhone—much commerce, many industries; (2) La Tour du Pin, on the Bourbre, 1046 feet above sea-level, beet-root sugar; (3) St. Marcellin, 1073 feet. 72. Drome. *Valence*, 56 miles south of Lyons, where Bonaparte studied (1785) and Pius VI. died (a prisoner) 1799, silk industries; (1) Montélimart, in rich vine district, 26 miles south of Valence; (2) Dié, Roman antiquities, extensive silk and woollen manufactures; (3) Nyons. Vaucluse. *Avignon*, 426 miles S.S.E. of Paris, papal residence 1309–76—seized by France 1791, fine broad quays border the Rhone—manufactures, silk-stuffs, taffeta, &c.—trade in madder, sumac, corn, cattle, books—J. S. Mill died here 8th May, 1873: the cavern and fountain of Vaucluse, celebrated in Petrarch's verse, 15 miles east; (1) Carpentras, 15 miles north-east of Avignon, Roman remains—nitric and sulphuric acids, almonds, honey, saffron, madder; (2) Orange, 12 miles north-east of Avignon: at death of William III. prince of Orange, the King of Prussia (to whom it fell) exchanged it for other territories—Roman antiquities; (3) Apt. 73. Bouches-du-Rhone. *Marseilles* [see p. 19], the best seaport—formed by an inlet of the sea—and the third city of France, in a valley surrounded by hills, in nooks of which nestle 10,000 country villas—shipbuilding and allied industries, active commerce; (1) Aix, founded B.C. 123, seized by Charles V. (1535), who was here crowned King of Arles—famous for sweet oil, almonds, dried fruits, confectionery, hot springs; (2) Arles,

against the French in 1813, in answer to Frederick William's address, "An mein Volk;" Glogau, fortified military depot, trade in liqueurs, vinegar, and beet-root sugar; Gorlitz, on the Neisse, fortified, with two strong castles. 6. Saxony, the northern portion of the kingdom of Saxony, ceded to Prussia at the Congress of Vienna—fertile and gently undulating. Capital, Magdeburg—one of the strongest Prussian fortresses, 80 miles south-west from Berlin, active trade, numerous public buildings, varied manufactures—taken and sacked by Tilly 1631, and by the French 1806; Halberstadt, a noble cathedral, active and varied manufactures—resisted the French in Thirty Years' War—taken 1758 and 1809, under its walls Tchernichef defeated the Westphalians (1813); Halle, on the Saale, celebrated university, immense salt quarries, birthplace of Handel (1684–1759); Erfurt, on the Gera, Dom-Kirche, with "grosse Susanna" bell, 275 cwts., Luther's convent-life (1505–12)—manufactures, woollens, silks, cottons, shoes, &c. 7. Schleswig-Holstein—two duchies, formerly the southernmost portion of the kingdom of Denmark, but since 1864 (after a war between Denmark and the states of Prussia and Austria) a Prussian province: Schleswig, on the west shore of the Bay of Sley, with a shallow harbour and small trade, fine Gothic cathedral and Gottorp Castle; Kiel, on the east end of the Holstein canal, constructed (1777–84) to form a communication between the North Sea and the Baltic; Flensborg, a flourishing sea-port, with excellent harbour, on a fiord of the Baltic; Lauenburg, on the right bank of the Elbe, a separate duchy, sold in 1865 (after the war) by Austria to Prussia for 2,500,000 dollars. 8. Hanover, formerly an independent kingdom, which, after being invaded and subdued, was declared an integral portion of the kingdom of Prussia in 1866: Hanover, its capital, was founded in the eleventh century; near it is Herrenhausen, George I.'s palace, birthplace of Sir Wm. Herschel (1738-1822), and of the Schlegels; Hildesheim, noted for its cattle fairs, considerable trade in linen and yarn; Göttingen, seat of a university,



Berlin

founded by George II., 1734. 9. Westphalia, south of Hanover; Munster, on the Aa, an affluent of the Ems—the church of St. Lambert, in the tower of which are the iron cages in which John of Leyden, founder of the Anabaptists, and his two agents, were confined and tortured; Minden, where the French were defeated by the English (1759); Paderborn, at the source of the Pader, which flows into the Lippe, a walled city with trade in corn, oil, and timber—manufactures, beer, spirits, tobacco, &c. 10. Hesse-Nassau, ceded to Prussia by the treaty of Berlin (1866), comprises the former electorate of Hesse-Cassel, the landgraviate of Hesse-Hamburg, parts of Hesse-Darmstadt and of Bavaria, the free state of Frankfurt-on-the-Main, and the duchy of Nassau; Cassel, an active industrial centre, whose new town is as fine as any city in Germany—near it is the palace of Wilhelmshöhe, whither Napoleon III. was sent after his surrender at Sedan (1870), the château of Wilhelmsthal, formerly the residence of the Elector, capital of Jerome Bonaparte as king of Westphalia, wool market, and two annual fairs; Marburg, on the Lahn, castle of Hesse, and a university; Fulda, a walled city on a river of the same name, famous manufactures of musical wind instruments, artificial flowers, wax-lights, and cotton goods; Wiesbaden, on the Salzbach, a health-resort for use of saline springs and baths; Frankfurt-on-the-Maine, 1600 feet above the sea-level, and about 18 miles from the influx of the Maine into the Rhine—the Romer, in the archives of which is still preserved *The Golden Bull*, containing the constitutions of the Empire, and in which the German emperors were elected, the cathedral in which they were crowned, and the Thurn and Taxis palace where the Germanic confederation held their sittings—birthplace of Goethe (1749-1833); Nassau, an old town, the centre of the Rhingau wine district, known as Nasonga in 790, birthplace of Baron von Stein. 11. Rhenish Provinces, comprising the former duchies of Juliers, Cleves, Berg, and the old grand-duchy of the Lower Rhine; Cologne (including the garrison-suburb of

Deutz), birthplace of Agrippina, who planted here a Roman colony—most magnificent Gothic cathedral in the world (1248–1880)—active trade in cottons, woollens, silks, velvets, tobacco, brandy, eau-de-Cologne, &c.; Bonn, celebrated university, founded in 1818 to replace one at Cologne founded 1385, suppressed by the French (1797), birthplace of Beethoven (1770–1827); Düsseldorf, at the influx of the Düssel to the Rhine, carries on a considerable trade in colonial produce, wines, coals, timber, slate, cottons, wools, and has manufactures of various useful articles; Elberfeld, a flourishing manufacturing town on the Wipper, extensive dyeing, bleaching, and print-works—manufactures, merinos, fancy woollens; Barmen and Elberfeld, which adjoin each other, supply all Germany with tapes and ribbons—a higher-class technical school is famous for the splendid training it provides; Coblenz, at the confluence of the Moselle and Rhine, near it is Ehrenbreitstein, the strongest fortress in Europe, on a precipitous height 770 feet high, birthplace of Prince Metternich (1773–1859); Aix-la-Chapelle (Aachen), a quiet old city of much historic interest—minster modelled after the Church of the Sepulchre at Jerusalem, begun by Charlemagne—his burial place, and the Coronation Hall, where thirty-seven German emperors and eleven empresses were crowned—the treaties of 1668, 1748, 1818. 12. Hohenzollern (Hechingen and Sigmaringen), two principalities resigned to Prussia in 1850 for suitable pensions. The offer of the crown of Spain to Prince Leopold of Hohenzollern, in 1870, was the ostensible cause of the war between France and Germany. See p. 1354.

II. *Bavaria*, an inland, rather mountainous, agricultural country, comprising the former duchies of Bavaria and Nürnberg, the principalities of Anspach, Baireuth, Bamberg, and Würzburg, and the Upper Palatinate of the Rhine. In the war of 1870 Bavaria fought for Prussia, and is now the second kingdom in extent and population in the German Empire. It is divided into eight provinces (called circles)—(1) Upper Bavaria: Munich, on the west bank of the Isar, famous for its public buildings—the Königsbau and the Festsaalbau, the Pinacothek and the Glyptothek, the chapel royal and the cathedral. It is celebrated for its lithography—invented by Aloys Senefelder (1771–1834)—engraving, glass-painting, and optical instrument making, bronze and iron art works, &c. Its literary, art, scholastic, and charitable institutions are numerous. (2) Lower Bavaria: Landshut, 39 miles north-east of Munich, on the Isar, inclosed by old fortifications. From the steeple of St. Martin's a panoramic view of the whole Bavarian plain may be had; trade in cattle, wool, and corn, distilleries and breweries. (3) Upper Palatinate: Regensburg (Ratisbon), in an extensive and fertile valley at the confluence of the Regen with the Danube, was a place of trade in the second century. In 1806 the German princes here placed themselves under Napoleon; near it is a monument erected in 1817 to Kepler (1571–1631), and the Walhalla—a Doric imitation of the Parthenon, raised by Ludwig in honour of the great men of Bavaria. (4) Upper Franconia: Baireuth, a pleasant, well-built, six-gated city; St. Mary's Church, built 1446; birthplace of Moritz Wagner (1813–83). (5) Middle Franconia: Anspach, well and regularly built at the confluence of the Rezat with the Holzbach, in a fine fertile valley; trade in flax, corn, and wool; manufactures, earthenware, linens, cottons, woollens, cutlery, &c. (6) Lower Franconia: Wurzburg, on the Main, on the bridge over which there are twelve colossal statues of saints; cathedral, built eighth century; citadel of the Frauenberg, 400 feet high; considerable trade and manufactures—a railway centre. Aschaffenburg, beautifully situated on the Main, famous as an educational centre; the Johannisberg Palace, the town hall, and the old mansion of the Teutonic order are noteworthy. (7) Swabia: Augsburg, the principal seat of commerce in South Germany, and a large entrepôt for the transit of merchandise; its town-hall is one of the finest in Germany; in the bishop's palace Luther presented the Confession of Augsburg (1530) to Charles V. (8) The Palatinate of the Rhine: Spires, where, in 1529, the Reformers *protested* against the proceedings of the emperor; a cathedral founded by the Emperor Conrad, 1030; during the war of the Orleans Succession, in 1689, it suffered severely, and in 1794 it was overrun by Custine.

III. *Saxony*, diversified by mountain, hill, and plain, rich in minerals, highly fertile, and, next to Britain and the Netherlands, the most prosperous manufacturing country in Europe. Dresden, on both sides of the Elbe, over which there is a bridge 1420 feet long; an entrepôt for colonial and foreign produce; has six annual fairs; its mechanics are noted in porcelain, jewelry, turning, the making of mathematical and musical instruments, &c. Leipzig, on the Pleisse, flourishing commercial city; great book fair; celebrated university; birthplace of Leibnitz (1646–1716); Napoleon I. defeated, 1813. Freiburg, 1179 feet above sea-level, on the Erzgebirge, famous for its mining industries; manufactures gold and silver wares and lace; tomb of A. G. Werner (1750–1817), geologist, and monument of Elector Maurice (1521–53). Meissen, wines; "Dresden china." Chemnitz, the German Manchester, birthplace of Puffendorf (1632–94).

IV. *Würtemberg*, a kingdom of South Germany, fertile in soil, rich in timber, minerals, &c., abounding in salt-springs, and having numerous industries; chief rivers, Danube and Neckar, with the Swabian Alps as watershed. Stuttgart, near junction of Nesenbach with Neckar, famous for metal-working, instrument-making, statues of Schiller (by Thorwaldsen) and Blücher—royal library, with more than 12,000 editions of Bibles in all languages. Tübingen, famous university, founded 1477; good trade in agricultural produce, wine, fruit, &c. Ulm, at inflow of Blau to Danube, considerable transit trade; manufactures, linens, cottons, woollens, silks, paper, Ulmer pastry, &c.; capitulated to Napoleon I. 1805. Heilbronn, large market-place with fine fountains; active trade, oil, paper and gypsum mills, shot foundry.

V. *Baden*, a mountainous state in South-west Germany, including the Black Forest and the Odenwald, bounded S. and W. by the Rhine. Constance, capital of the district and situated on the Lake of Constance, famous for council (1414–18) which sentenced Huss and Jerome to the flames and condemned Wycliffe's doctrines, deposed three rival popes and elected Martin V.; manufactures silk, cotton, watches, &c. Freiburg, capital of district of Freiburg, Gothic minster of twelfth century; statue of its founder, Duke Berthold III. (1118); manufactures, paper, gunpowder, bells, soap, potash, &c.; university. Mannheim, capital of district of same name, active trade by rivers Neckar and Rhine and by railways; bleaching works, tanneries, shawl and linen manufactures. Carlsruhe, capital of district founded by Margrave Charles William (1715), built in the form of an extended fan with palace as centre, active trade and manufactures. Heidelberg Castle, former residence of the Elector Palatine, ruined by lightning 1764; from Königstuhl (2000 feet) a magnificent view is gained; *tun*, capable of holding 800 hogsheads; oldest university in Germany, founded 1386.

VI. *Hesse*, a fertile agricultural state in West Germany: Mainz (Mentz or Mayence), an imperial city and free port, with few manufactures, but considerable commerce—birthplace of Gutenberg (1400–68), to whom a statue by Thorwaldsen was raised (1837); Giessen, university founded 1607, famous school of chemistry.

VII. *Mecklenburg-Schwerin*, a maritime grand-duchy on the Baltic—soil fertile, pasture excellent, timber fine, fish abundant, lakes numerous: Schwerin, on lake of same name, 60 miles east of Hamburg, finely situated, well-built, ancient Gothic cathedral, &c.; manufactures, lacquered wares, chocolate, linens, woollens, &c.

VIII. *Mecklenburg-Strelitz*, a grand-duchy of two detached portions, 997 square miles in extent; capital, New-Strelitz, ducal residence, mint, &c.

IX. *Saxe-Weimar*, a grand-duchy on the northern frontiers of the Forest of Thuringia, area 1421 square miles: Weimar, the German Athens, on the Ilm, birthplace of Kotzebue (1761–1819)—Goethe, Schiller, Herder, Wieland, made it a literary, and the court makes it a social centre—Falk's institution for destitute children; Jena, on the Saale, famous university, founded 1557—defeat of Prussians by French (1806); Eisenach, at the confluence of the Hörsel and Nessel, commanded by the mountain-fastness; Wartburg, with its castle, where the Minnesängers held their contests, and where Luther translated the New Testament (1521).

X. *Oldenburg* (with the principalities of Lübeck and

Birkenfeld), a maritime grand-duchy, bounded by the North Sea and the Weser, part of the great sandy plain of North Germany: capital Oldenburg, on the Hante, seat of an active river-trade—great cattle and horse fairs.

XI. *Brunswick*, three large unconnected districts in the north-west of Germany, and the three bailiwicks of Ottenstein, Thedinghausen, and Calvörde: capital Brunswick, on the Ocker, founded 861, favourite residence of Henry the Lion—two great fairs, a wool market, and six cattle markets—birthplace of Meibom (1638–1700) and Henke (1752–1809).

XII. *Saxe-Meiningen*, a duchy of Central Germany which, with the principalities of Hilburghausen and Saalfeld, extends in a semicircle along the banks of the Werra, and is skirted by the Thuringian Forest, consisting mainly of arable, pasture, and wood land, though rich in minerals and mineral springs: Meiningen, 40 miles S.S.E. of Erfurt, a neat town with ducal palace; Hilburghausen, 20 miles east of Weimar, woollen and linen manufactures.

XIII. *Saxe-Altenburg*, a small duchy on north frontier of the Thuringian Forest, hilly, wooded, and fertile, exports corn, cattle, wool, butter, and wood: Altenburg, on the Pless, 24 miles south of Leipzig, well built and flourishing.

XIV. *Saxe-Coburg* and *Gotha*, a duchy consisting of two large and several small detached territories, of which the total area is 816 square miles, almost entirely mountainous: Coburg, an old irregularly-built town on the Itz—ducal palace and many fine castles—linen, woollen, and cotton manufactures; Gotha, 25 miles west of Weimar—manufactures, porcelain, and lacquered wares.

XV. *Anhalt*, a duchy of Central Germany, hilly in south-west districts, but elsewhere flat: Dessau, on the Mulde, 80 miles from Berlin—manufactures, cloth, hats, leather, hosiery, &c.—birthplace of Moses Mendelssohn, "the Jewish Socrates" (1729–86); Zerbst, on the Nuthe, 13 miles north-west of Dessau—porcelain and wax manufactures.

XVI. *Schwarzburg-Rudolstadt*, a small principality, pasture and flax-growing country, with some minerals: Rudolstadt, on the Saale, 20 miles south of Weimar—trade in fruit, woollen and calico manufactures.

XVII. *Schwarzburg-Sondershausen*, a small, well-wooded, fertile, flax and corn-growing principality: Sondershausen, at junction of Wipper and Bebra, with smelting furnaces and porcelain works.

XVIII. *Waldeck*, a mountainous principality in the north-west, soil sterile and stony, yet well-timbered and pastured, minerals abound: Arolsen, on the Aar, woollen, leather and iron manufactures—ducal palace.

XIX. and XX. *Reuss*, the lordship (1) of Greiz, the portion of the elder, and (2) of Schleiz, the portion of the younger line of the family of Reuss, descendants of Henry the Fowler (876–936).

XXI. and XXII. *Schaumburg-Lippe* and *Lippe-Detmold*, a principality taking its name from the Lippe, an affluent of the Rhine, but divided between the descendants of the house of Lippe, founded in the thirteenth century. The former is the smaller, 212 square miles, having as chief towns Buckeburg, Hagenburg, and Stadthagen; the latter the larger and more compact, 432 square miles; chief towns—Detmold, Lemgo, and Horn.

XXIII.–XXV. The *Hanse-Towns*: (1) Lübeck, between the Trave and the Wakenitz, 36 miles north-east of Hamburg, near the Baltic, the main trade of which is carried on with Norway, Sweden, and Russia; (2) Bremen, about 50 miles from mouth of Weser, doing a great transit trade, especially as an entrepôt for American traffic—its municipal wine-celler is the most famous in Germany; (3) Hamburg, on the Elbe, 75 miles from the North Sea, a commercial city, and the great emporium of North Germany—the chief employments are those of commerce and navigation; next to London it has the largest money-exchange transactions in Europe.

XXVI. *Elsass-Lothringen* (Alsace-Lorraine), an Imperial territory or Reichsland, governed by a Stadtholderate, annexed by France in 1648–97, and re-annexed by Germany in 1871. It occupies the fertile plain between the Rhine and the Vosges Mountains: Strasburg, in a flat in the valley of the Rhine, surrounded by twelve massive forts, and traversed by the Ill—Cathedral of Notre Dame, originally founded 504, present structure built 1015–1439, clock 1571—monuments to Desaix (1768–1800) and Kleber (1800), statue of Gutenberg—active transit-traffic and manufactures; Mulhausen, chief town of Ober-Elsass, a miniature Manchester, varied manufactures, great trade, the "workmen's city;" Metz, at the junction of the Seille with the Moselle, engirt by forts—ancient capital of Austrasia, an Imperial city 985—many industries and much trade—cathedral 1014–1546, restored 1871–75.

The principality of Liechtenstein, between Switzerland and the Tyrol, belonging to one of the oldest and most illustrious of the princely houses in Europe—though the smallest of all the sovereign principalities in the Germanic Confederation of 1866—has remained by agreement independent of the German Empire. It contains 8000 inhabitants; chief town, Vachez—population, 1700.

The colonies and dependencies in Africa are: (1) Togoland, adjoining the Gold Coast; (2) Cameroons; (3) Damara; (4) Namaqua; in the east a commercial company claim some settlements recently defined by an international commission behind Zanzibar, with stations at Durnford, near Juba, in Chaga, Usagara, &c.; (5) in the Pacific, on the north-east of New Guinea, Kaiser Wilhelm Land, Bismarck Archipelago, and the Marshall and Gilbert islands.

FRENCH LITERATURE.—CHAPTER III.

POST-REVOLUTIONARY, IMPERIAL, AND REPUBLICAN LITERATURE.

The passionate storm of the Revolution and the fiery tempests of the First Empire seem for a time to have withered and scorched the genius of man. But it renewed its vigour and development in a vagrant and wildish strength of productiveness, in which are found many elements new to French literature. Greater freedom of form and matter, wider and wilder range of topic, less care for classical writers and rulers, more frequent escapades of fancy, humour, and emotion, and louder cries for change, freedom, and the rude brotherhood of Bohemian socialism, are manifested. Art is not cultured for art's sake, but for the colouring, brilliancy, and attractiveness it lends, and for the opportunities it affords of strange suggestion through exquisite expression. Poetry becomes more intensely emotional, and casts aside the shackles of conventionality; prose takes a more distinctly picturesque and emotional expression; philosophy is eclectic and illustrative; politics glows into oratorical effusiveness; and literature blooms into many hitherto unknown, or at least unacknowledged, forms of flower and fruit. Of a few of the most notable of those who were cradled in these stormy times and influenced in their youth by them, as well as of those who came under the impress of their fascinating power, notice will be required; but this must be both select and brief.

Pierre Jean de Béranger, the most famous of the national poets—and sometimes spoken of as the Burns—of France, was born in Paris on 19th August, 1780. His father, a vain and ardent Royalist belonging to Flamicour, near Péronne, was a Gallican Micawber, always expecting something to turn up, but unwilling to turn anything up for himself. Pierre was brought up by his grandfather, a poor tailor, and in his ninth year witnessed the taking of the Bastille. Forty years afterwards he celebrated it in the prison of La Force. During the Revolution he acted as pot-boy to his aunt, who kept a small inn in Péronne. Here he read Fénélon, Racine, and Voltaire, and having been apprenticed to a printer, he attended the primary school of M. Bellus, a Rousseauist, began to write verses and, by studying Fontaine and Molière, to form a style. His father called him to Paris to assist him in some (unsuccessful) commercial speculations, and he endured great privations. At length, urged by the courage of despair, Béranger sent copies of his poems with an autobiographical letter to Lucien Bonaparte, the First Consul's brother, who procured for him an appointment as clerk in the office of the University. From this he was dismissed in 1821, when he was, for his satirical verses, "Le Sénateur" and "Le Roi d'Yvetot," sentenced to three months' imprisonment and fined 500 francs. He was again, in 1828, sent

nine months to gaol and fined 10,000 francs. The latter was defrayed by public subscription. Editions of his poems were published in 1815, 1821, 1828, 1833, and 1847. In 1848 he was chosen a member of the National Assembly, but refused to serve. Napoleon III. and the Empress Eugênie strove to win him to their side, but he resolutely refused their most flattering and tempting offers. He died on 17th of July, 1857. The Emperor decreed him a public funeral, and more than 300,000 followed his remains to the grave. French critics pronounce "Les Hirondelles," "Le Cinq Mai," "Le Vieux Vagabond," "L'Alchimiste, "L'Orage," "Le Dieu des Bonnes Gens," "Le Champ d'Asile," "À mes Amis," and "La Sainte Alliance des Peuples" as his masterpieces. The reputation of Béranger as the chief song-writer of the age has spread into all lands. Châteaubriand quotes the following stanza of his bacchanalian song, "To the God of Jolly Fellows," as "worthy of Tacitus, who also wrote verses":—

"Un conquérant dans sa fortune altière
Se fit un jeu des sceptres et des lois;
Et de ses pieds on peut voir la poussière
Empreinte encore sur le bandeau des rois."

C. J. Pioult de Chènedollé (1769–1833) was educated by the Cordeliers of Vire and was brought up by the Oratorians of Juilly, where he had Fouché for a teacher. In 1791 he became an *émigré* with the princes, and resided successively in Holland, Switzerland, and Germany. He returned to Paris in 1799, and was appointed, under the empire, inspector of the Academy of Caen. He was inspector-general of education when he died at Coisel. His "Génie de l'Homme" is a philosophic and descriptive poem, full of deep thought and highly picturesque expression, intended to rebut the errors of Rousseau's "Contrat Social," and to defend civilization. It marks the transition from classicism to romanticism. His "Etudes Poétiques," such as his *éloge* on Bossuet, in which there are many splendid verses, appeared in 1820, at a time when Lamartine and Hugo were eclipsing the poetry of the past. Chènedollé's complete poems were published in 1865, and rank among the best modern pastoral and didactic writings of the times of the empire.

Alexandre Soumet (1788–1845), born at Castelnaudary, was intended for a military career, but failed at his entrance examination, and went to Paris, where he devoted himself to literature. In 1805 his poem, in three books, "L'Incrédulité," attracted Napoleon, who made him auditor of the Council of State. His elegy, "La pauvre Fille" (1814), secured by its feeling and sympathy immediate popularity. His poems on "The Discovery of Vaccination" and the "Last Moments of Bayard" were crowned by the Academy. At the Restoration he was appointed librarian of St. Cloud and subsequently of Compiègne. His lyric verses charm and fascinate; his "Divine Epopée" (1848), a French "Messiah," has many fine conceptions nobly executed, but is probably too ornate and extravagant. In it Jesus, by preaching to the spirits in prison, rescues Satan and the fallen angels from the doom to which they had been consigned. "Joan of Arc," published posthumously in 1846, is sonorous, expressive, and picturesque. He began as a playwright in 1822 with "Clytemnestre" and "Saül." These he followed by "Cléopatre," "Elisabeth de France," "Norma," "Le Gladiateur," "Le Chêne du Roi," "Jane Grey," &c. Lamartine says he is as an elegist as tender as Chénier, and in his epics as melodious as Racine. His plays are marked by quietness of plot, but intensity of character.

C. H. Millevoye, born at Abbeville 24th December, 1782, was a merchant's son. He early displayed a sweet, dreamy, sensitive nature; took the first prize in literature, 1798, in the Central College of the Four Nations; and tried the bar, but relinquished it. His poems were *couronnés* regularly by the Academy (1804–12). His "Chute des Feuilles," for delicate sensibility and pleasing melancholy, is as famous in France as Gray's "Elegy" in England. He wants sustained grace and emotive power in his larger heroic poems "Charlemagne" and "Alfred," and his three (unacted) dramas, "Antigone," "Saül," "Ugolin." He translated the Iliad and Virgil's Bucolics. He has been called "un doux précurseur de Lamartine." He suffered from consumption, but died in consequence of a fall from his horse, 26th August, 1816.

Antony Deschamps was born in Paris in 1800. His father was a man of letters. Antony had a poetic nature, but a morbid melancholy embittered his whole existence. He translated Dante (1829), issued "Satires Politiques" (1831), "Dernières Paroles" and "Résignation" (1835), and closed the long agony of his life at Passy, 29th October, 1869. Here is a poet's cry—

"Prêtre de Jésus Christ, parle-nous de la croix:
Parle-nous de la croix, de cette croix austère
Que ton maître a portée au sommet du Calvaire,
Que porte le vulgaire, et que porte le roi,
Que tu portes toi-même, et que je porte moi."

The one name which renders the period 1789–1816 illustrious, and without which the literature of France during the Revolution and under the Empire would be, if not a blank, a mere list of mediocrities, is that of François Auguste, Vicomte de Châteaubriand. He linked the literary period of Voltaire, Diderot, and Rousseau to that of Lamartine, Victor Hugo, and George Sand. He alone could captivate the popularity of Europe by the finest prose composed in imperial France. Born the tenth child of an ancient but impoverished family at Malo in Brittany, in the same year as Wellington, Cuvier, and Napoleon (1768), and buried in a self-chosen grave on an island in the bay fronting his native place, July, 1848, his long career of eighty years of inexplicable selfishness ran parallel with that of the First Emperor, and closed at the dawn of the era of Napoleon III. Châteaubriand was destined for the church, but abandoning it, entered the army as a sub-lieutenant, 1786. In 1791, he says, "we were both then, Bonaparte and I, but sorry sub-lieutenants, utterly unknown; we both started from the same obscurity at the same epoch." All his life he held himself as the rival of that leading star among the actors on the stage of Europe, and sought to startle the public with similar theatricality. He was present at the taking of the Bastille, went to America, and sought there the ideal, free, savage life of which Rousseau had rhapsodized, but only found the material for his romance "Les Natchez"—of which "Atala" and "René" were only episodes—sent forth in the pages of *Le Mercure* as heralds of "Le Génie du Christianisme" (1802), the teaching of which Napoleon epitomized into an equivocal sentence—"Worship is everywhere man's instinct, for there lies truth." The author had been in England nearly eight years: in London he issued his "Essay on Revolutions," quite a sceptical work; in 1798 his mother died, and, brought to reflection by this event, he exclaims: "Je n'ai point cédé, j'en conviens, à de grandes lumières surnaturelles; ma conviction est sortie de mon cœur—J'ai pleuré, et j'ai cru!" This was effective, and France accepted his emotional version of Christian faith.

Jean Reboul, son of a locksmith, was born at Nîmes on 23rd January, 1796. He had little schooling, and began his life of labour at thirteen as a baker. He employed his scanty leisure in self-culture, and in 1828 acquired repute by his elegy—taken from Grillparzer—"L'Ange et l'Enfant." It moved all hearts. Painting, music, and sculpture drew inspiration from it. Lamartine in his "Génie dans l'Obscurité," devoted a "Harmonie" to the praise of the baker-poet, and Châteaubriand celebrated him. A. Dumas called him "son frère en poésie." His first volume, under such auspices, passed through five editions within a year. In 1839 Reboul issued his "Le Dernier Jour," and took to a literary life. In 1848 he was chosen a member of the National Assembly, but soon demitted his seat. His tragedy, "Le Martyre de Vivia," did not succeed at the Odéon (1850). He is least effective when he attempts academic language, but never fails, in his smaller and simpler pieces, to leave an ineffaceable impression on the heart by the purity, delicacy, and beauty of his verse.

Alfred Victor, Comte de Vigny, distinguished both as a poet and a prose writer, was born at Loches in 1799. He came while a youth to Paris, where he caught the prevailing war-fever. At sixteen he was made a Red Musketeer, and accompanied Louis XVIII. to the frontiers. He next entered the Infantry of the Guard in 1816, and in 1823, as a captain of the 55th Regiment of the Line, took part in the Spanish campaign. In 1828 he devoted himself to the more peaceful pursuit of poetry. In 1822 he had issued "Helena," "La Somnambule," "La Fille de Jephté," "La Prison," and "Le

Bal." He wrote peculiarly under Biblical inspiration, and was a special student of scripture. His "Moïse" is a very noble conception. "This man, chosen of God, overburdened with the cares and sorrows of greatness, cries for rest and peace. When the clouds on Nebo's breast disperse he has joined 'the choir of the invisible,' and Joshua is left to lead the Israelites into the promised land." "Eloa" is the story of a bright angelic being formed from one of the Redeemer's tears, who falls through pity for the Great Spirit of Darkness, who lost heaven by pride. His verse is sweet, harmonious, and elegant, but deficient in poetic power and the lofty inspiration of genuine passion. His novel, "Cinq Mars" (1826), has been translated into many languages; his version of "Othello" was performed in the Théâtre Français in 1829; his "Stello"—the man of genius persecuted by the world—came out in 1835. From it he took the episode of "Chatterton," and transformed it into a splendid literary drama. "Poèmes Philosophiques" appeared in 1856. Two years later he was received into the Academy. "Les Destinées" was issued shortly after his death, 18th September, 1863.

In 1820 the "Méditations Poétiques" were published. They spoke of the delusions of life, the sorrows of the heart, the upward yearnings of the soul, the joy of holy hope. They were the productions of Alphonse-Marie L. Pradt de Lamartine, born at Mâcon in 1792. He had been educated at Belley and in Italy. The success of this work—of which 45,000 were sold in four years—opened to him a diplomatic career, and he was ultimately elected deputy to the Chamber, where by brilliancy of intellect, dash, tact, and liberality of view he won admiration. In 1848 he acted with the revolutionists, and became a member of the provisional government. His patriotism and power, prudence and eloquence, largely aided in restraining anarchy in Paris. He was named for the presidency, but the *coup d'état* consigned him to poverty and private life. He is one of the picturesque writers who fascinate the imagination and modulate their style to every phase of thought or incident. His "New Meditations," "The Death of Socrates," and "Last Canto of Childe Harold" appeared in 1823. They were moderately successful. In the first "Le Crucifix" is a splendid poem, and in the last there is a tirade against Italy, closing with these lines—

"Je vais chercher ailleurs (pardonne, ombre Romaine!)
Des hommes, et non pas de la poussière humaine,"

which led to a duel, in which the poet was dangerously wounded. The "Harmonies" appeared in 1829. In these he seeks, by analogy, to make the world a revelation of the Creator. His domestic epic, "Jocelyn," who is devoted to the priesthood that his sister may have his share of the family inheritance to secure her settlement in life, and, excited by the Revolution, falls in love with a young orphan lady entrusted to his care; accepts holy orders, flees from the lady's presence, and becomes *curé* in an Alpine village; preaches in Paris, sees the lady in all her blaze of beauty, and hastens off to his distant charge. Many years after, he visits a sick lady who, not knowing him as a priest, confesses that she dies heartbroken through unreturned love. Jocelyn reveals himself, but ere she can kiss his hand she expires. On his death, he is buried by his parishioners in the lady's tomb. "La Chute d'un Ange" (1837) was scarcely so popular. His prose tales are the favourites for reading at the home-hearth, for all that he writes is chaste and pure, and his style is at once pellucid and pleasant. His poetic imagination imparts form and colour to his histories of the Revolution, of the Restoration, and of Turkey. No French author has written more, and all so well, as Lamartine; and his own life has been a realized romance. His illusive wealth, his expensive habits, his straitened circumstances, the artifices employed to procure funds, his state pension, and his simple funeral at Saint Point, near Mâcon, where he died on 1st March, 1869, form a strange and medley end to the life of one of the most remarkable literary and political Frenchmen of this century.

The elegiac "Messéniennes" of Casimir Delavigne (1793–1843), in which the sorrows of France were mourned and the vanity of the French flattered, appeared in 1824, and gained instant recognition. "Parthenope," "Waterloo," and "Napoléon" are the three best of these fine poems. In 1830 his song, "La Parisienne," rivalled in popularity "La Marseillaise." His poems are happy thoughts happily expressed.

Alfred de Musset (1810–57) has been called "the Tennyson of France." His "Lettre à Lamartine," "Espoir en Dieu," and "Les Nuits" are his best efforts. His song in reply to Becker's German war lyric on the Rhine in 1840, "Nous l'avons eu, votre Rhin Allemand," was adopted by the French in 1870. He was a dramatist, novelist, essayist, and historian. Sainte-Beuve, the critic and essayist, has written poetry marked by elegance and good taste. In Emile Deschamps' "Etudes Françaises et Etrangères" an exotic fragrance predominates, but they are sprightly and pleasing. Auguste Barbier's "Iambes" are wildly democratical, dignified, and ironical. Théophile Gautier has produced some exquisite poetry, remarkable alike for originality of matter and beauty of form, and justly entitled "Emaux et Camées" (1852), besides many popular fictions—*e.g.* "Mademoiselle de Maupin," "Une Larme du Diable," &c., and numerous dramas, vaudevilles, as well as innumerable papers in magazines, reviews, &c. Among female poets Madame Amable Tastu is notable for harmony, elegance, and melancholy grace. Delphine Gay [Girardin] (1804–55) bears fair repute as a poet, playwright, and *saloniste*. Mélanie Villeneuve [Waldor] exhibited poetic sensibility, capacity of telling a fine tale in a graceful fashion, and sagacious sympathy with children; and Anaïs Ménard [Ségalas] attracted attention as an agreeable, kindly, able, and spirited woman of talent, wit, genius, and influence. In romance, Madame de Staël's "Corinne" is affecting in plot, pleasing in style, abounding in reflections, but faulty in structure, and unnatural and unreal in the conduct of its characters. It is in *morale* greatly superior to "Delphine." De Staël was one of the most influential politico-literary women of her time. Her book "De l'Allemagne" induced the writers of France to adopt romanticism.

Victor Hugo's magnificent but hectic imagination—displayed alike in ode, ballad, lyric, drama, or novel—inherited the disturbed unsoundness of the Revolution. His "Han d'Islande" (1823) is a fantastic savage man-beast of far worse type than Caliban. "Bug-Jargal" (1826) is a simple touching story of a heroic negro, but the interlaced mystery of Captain Dauvernay's grief is not well conceived. As a psychological study "The Last Day of a Condemned Man" (1829) is curiously felicitous in form and infelicitous in matter; but as a tale with a moral against capital punishment it is very inept. The poetico-social polemics of Hugo appear even in his masterpiece "Notre Dame de Paris" (1831). Superbly graphic and gloomily overmastering, the lurid story is splendidly told, and the disastrous romance harrows like the chaos caused by a volcano. It gave him the chief place in European fame, in rivalry with Scott and in succession to Byron, and this, by "Les Misérables" (1862), he has maintained, though it requires a great deal of the salt of genius, skill as a narrator, and rich brilliancy of style to counteract the evil atmosphere of the artificial hells of civilization he invites one to breathe in it. In the "Lêgende des Siècles" Hugo, with victorious puissance, makes the French Alexandrine ductile to his aims. Though he is not, as M. Coppée says, "the greatest lyric poet of all ages," he has composed much verse with wondrous music in it. In his dramas, "Hernani," "Lucrèce Borgia," "Cromwell," "Marie Tudor," "Ruy-Blas," "Torquemada," &c., romanticism triumphed. In his anti-Napoleonic writings his scorn is as theatrical as his antagonist's sovereignty. All Hugo did was striking; much of it is distinctly great and enduring.

The mind of Honoré de Balzac (1798–1850) is that of a clear mirror, smashed in the revolutionary crisis, showing society in all its varieties, especially the female sections of it, in the singularly diversified and yet accurate manner of such a looking-glass of life. His imagination is inexhaustibly sprightly, and he compels interest in much from which one would rather withhold one's heart. He is very unequal. His best and choicest are "Eugénie Grandet," "Louis Lambert," "César Birotteau." Some of the short tales in the various volumes of "Scenes" are exceedingly good. His "Contes Drolatiques" are as grossly sensualistic as his model, Rabelais.

George Sand (Madame Dudevant, *née* Dupin, 1804–76) wrote in co-operation with Jules Sandeau—author of

"Madame de Sommerville" (1834), "Olivier" (1854), and other novels and dramas—"Rose et Blanche" (1832) and "Indiana" (1833). The celebrity thus attained she sustained in "Valentine," "Lelia," "Jacques," &c., novels opposed, not as many suppose, to the reasonable and holy relations of marriage, but to *mariages de convenance.* Her tone and aim are higher in "Simon," "André," "Mauprat," and the rather mystical "Spiridion." Her autobiography, in many volumes, possesses more incident than many novels, for her life was one of varied *liaisons.* "Pauline" (1840), "Consuelo" (1842), its (inferior) continuation, "Princess de Rudolstadt" (1843), and "Meunier d'Augibault" (1845) are socialistic; "Elle et Lui" (1834) and "Lucrezia Floriani" (1838) are pamphleteerings against Alfred de Musset and Chopin. She wrote as well as lived too fast—for her times, not "for all time"—though with real genius and power.

The unfortunate moral refrain of Eugène Sue (1804–57)—that "on earth virtue is always wretched and crime constantly successful"—vitiates many singularly powerful fictions. His early writings were sea-novels, and their heroes are shameful in career, though shameless in conscience. He began historical novels—*e.g.* "Latreaumont," "Jean Cavalier," &c.; then *romans de mœurs—e.g.* "Arthur," "Hotel Lambert," "Mathilde;" next socialistic fictions—"The Mysteries of Paris," "The Wandering Jew," "Martin the Foundling." Seeking in *sensism* what exhausted sensualism could not now yield, a stimulant sensation, Sue wrote to show the fair side of "The Seven Cardinal Sins" and the "Mysteries of the People," condemned even in France. He tried politics, was exiled, and gradually, but justly, failed in popularity, for he represented all life in a perfect craze of sin. M. Corbière's nautical fictions, "Le Négrier," "Les Trois Pirates," "Plick et Plock," &c., and those of Jules Lecomte, "L'Ile de la Tortue," "Le Capitaine Sabord," &c., are free from the naughtiness of Sue.

M. Frédéric Soulié (1800–47) is a clear, forcible, attractive writer. "Le deux Cadavres," "Le Vicomte de Bézier," with its continuation "Le Vicomte de Toulouse," and "Le Conseiller d'Etat" are able and excellent. His "Mémoires du Diable" (eight vols. 8vo), the popularity of which induced Sue to take up his social fictions, are, however, more horrible in their pictures of life than Le Sage's "Le Diable boiteux."

Charles Paul de Kock has with immense fecundity produced upwards of fifty fictions, besides many tales, melodramas, operas, vaudevilles, &c., with such popularity that during his lifetime four collected editions of his fictions were eagerly bought up. His inventive genius and skill in characterization are unquestionable. His moral sense is not quite so nice and pure as his observation and his style. In his later years he exaggerated both in phase and phrase. "Georgette," "Gustave," "Frère Jacques," "André le Savoyard," "Jean," "Le Barbier de Paris," "Le Cocu," and "La Pucelle de Belleville" are in his first manner, and some of the best of his second series are "Zizine," "Un Tourlourou," a collection of tales of *bourgeoisie, grisettes,* and common people, entitled "Mœurs parisiennes," "Ce Monsieur!" "Tacquinet le Bossu," "Le Millionaire," "La Fille aux trois Jupons," "Enfants du Boulevard." The knowledge of life he mainly exhibits is the lower caste of French existence, rustic or civic. Jules Verne writes with amazing power some fanciful and attractive novels, calculated to excite thought on many scientific first truths. The Erkmann-Chatrian copartnery for the writing of historical novels has resulted in realizing many exciting episodes of life in the past; About's "Le Roi des Montagnes," "Germaine," and "Les Echasses de Maître Pierre," &c., are highly attractive. Murger, Souvestre, and Lascaris are much esteemed. Feydeau, Feiullet, A. de Musset, and Prosper Merimée deserve note as realistic writers, in a style which Gaborian has carried to excess. Salvandy's "Alonzo" pictures the Peninsular War. Jules Janin's "Barnave" shows a striking episode of the Revolution; his "Chemin de Traverse" teaches perseverance. M. Joseph Xavier Boniface (Saintine) in his "Mutilé," gives a tale of papal tyranny, and writes most gracefully in "Picciola or the Prison-flower." Alphonse Karr mixes irony with good sense and humour with fancy in "Sous les Tilleuls," "Une Heure trop tard," "Vendredi Soir," and the semi-autobiographical "Le Chemin le plus Court." "Geneviève" is a fine work, "Agathe et Cécile" is one of his best, while "Clotilde," "Hortense," "Feu Bressier," &c., hold a high place.

Alexandre Dumas *père* (1803–70) was a wholesale manufacturer of novels; a bare list of the dramas and fictions, consisting of 1200 volumes, would fill two pages of such a work as this, so prolific has he been. Alexandre Dumas *fils,* born 1824, has followed the course of his father. The former, a Franco-negro, roused by Kemble's acting of "Hamlet," produced "Henri II.," "Christine Thérèse," "Angelo," and a host of other successful plays, and as author of the novels "Monte Cristo," "Les trois Mousquetaires," and "La Reine Margot" won a world-wide fame. The latter, with singular precocity and vivacity, wrote some poems, entitled "Les Péchés de Jeunesse," and "Les Aventures de Quatre Femmes et d'un Perroquet" before he had come of age. His "Dame aux Camélias," "Dame aux Perles," "Roman d'une Femme," "Diane de Lys," and many others, show brilliancy, ingenuity, resource, and voluminousness. Gustave Flaubert (1821) by his "Madame Bovary" (1857) and "Salammbo" (1862) gained genuine success. Alphonse Daudet (1840) made slight success with "Les Amoureuses" (1858), "La Double Conversion" (1861), but rose into fame by "Fromont Jeune et Risler Aîné." It was *couronné,* and passed through forty editions. Emile Zola (1840), bred a bookseller, has displayed singular power with equally strange indelicacy in his "L'Assommoir," "Nana," &c. French fiction is in this, at least, true to the land of its origin—it, for the most part, carries in it signs of the strain and stain of the Revolution and the Empire. French novels are less domestic than theatrical. They may be representations of real life, but *outré*—the villainous, the passionate, the criminal and the sinful have too large a share in it. The average, honest, simple, common life and love of the people have too few works devoted to them. The realism which dwells only on diseased humanity without bringing it into relations of comparison and contrast with the sane forms of life, resembles the presentation of the inmates of hospitals, lunatic asylums, prisons, and the haunts of vice as a correct picture of social existence. Nothing could so favour the regeneration of France as the literary exhibition of a domestic and social life in which the true work and play of all the human feelings, emotions, and interests of the family and society were shown co-operating to the true happiness and prosperity of individuals and nations.

It was fortunate for France that the physiological metaphysics of Condillac and Helvetius, supported by the powerful advocacy of De Tracy, Cabanis, Garat, Volney, &c., and even modified and simplified by M. Laromiguière, was brought by P. P. Royer-Collard (1766–1824) under the transforming influence of the Scottish "common-sense" school. His inductive scientifico-historical lectures created the energetic eclecticism of which Victor Cousin (1792–1867) became the enthusiastic apostle. It accepts and works out the maxim of Leibnitz—that "systems are true in their affirmations, but false in their negations." History is the manifestation of ideas, and only by their truth do they survive, till, by a more inclusive truth, they are absorbed and supplanted. Thus truth is enlarged and self-luminous. Cousin—addressing audiences often of 2000—caused an unparalleled sensation, and yet he proclaimed Maine-de-Biran (1766–1824), whose works he edited in 1840, the chief metaphysician of France. His most distinguished pupils, Théodore Jouffroy (1796–1842), with greater precision of method and higher philosophical aim than Cousin, gave France its best system of ethics; J. P. Damiron (1794–1862) was an instructive critic and expositor of philosophy; and M. N. Bouillet (1798)—a man of multifarious attainments—edited Bacon and gathered round him the best thinkers of France as contributors to the *Encyclopædia of the Philosophic Sciences.* Students of philosophy will find succinct summaries of all speculative theories in M. Hippeau's "Histoire;" excellent outlines of thought in M. de Cordaillais' "Etudes," in the "Cours" of M. Mazure and M. Oganeaux; and profitable philosophic suggestions in the works of MM. Tissot, Poret, Paffe, Garnier, Gerusez, Caunes, Caro, Saisset, and many others. M. Pierre Leraux has, with profound skill, written the "Réfutation de l'Eclecticisme." Barthélemy St. Hilaire, C. de Ré-

musat, G. Vaqereau, Jules Simon, Duval Jouve, B. Hauréau, J. Matter, E. Naville, and many others, have contributed to the advancement of philosophic thought.

The Abbé de Lamennais (1782–1854) founded the theological scepticism of the nineteenth century. He destroys human certitude, and accepts universal consent as the authority for belief in Deity, acceptance of revelation, and recognition of catholicism; but his "Esquisse" has been found inept, and is a solitary though ably composed thesis. In "Les Paroles d'un Croyant" he developed a republican theocracy, composed in imitation of Job, Jeremiah, and Isaiah. It contains many exquisitely noble and affecting sentences. His "Le Livre du Peuple," "De l'Esclavage Moderne," "Le Pays et le Gouvernement" excited paroxysms of admiration and brought their poetico-religious writer into the grasp of the political prosecutor.

Philosophical socialism has been developed in France in three great schools: (1) that founded by Count C. H. de St. Simon (1760–1825), pupil of D'Alembert, soldier under Washington, speculator in land during the revolutionary excesses, and author of "A Plan for the Reorganization of European Society" (1814). This he developed into "St. Simonism," (called Nouveau Christianisme) 1825. It sought to make society a hierarchy, and "the labours of each conduce to the good of all." He was self-martyred to his ideal; becoming a pawnbroker's clerk, subsisting on a friend's charity, in his poverty attempting suicide, and yet being in his own belief and in the faith of many of the brightest minds of France, a noble apostle of the gospel of happiness. A much more original, profound, and sagacious advocate of the reform of the fundamental principles on which modern society is founded was Charles Fourier (1772–1837). He set out with a new view of the springs of human action, as attractions and repulsions, the coefficients of destiny. He proposed life in phalanges, *i.e.* in groups of families, in which the whole circle of human capacities should be included, employed, and enjoyed. Life is sensitive, affective, and distributive, and society should engage and gratify all human energies. So should man do and be his best, and sociology should be the practical realizing of all the good of earth and all the gladness of life, without fear and in the fulness of hope. He was a voluminous enthusiast, and many of his hints and suggestions are really worthy of consideration. Very heartily he denounced "the snares and quackeries" of the St. Simonians and the Owenites (1831). Auguste Comte (1798–1857) endeavoured to make socialism scientific. He recognized all experience as phenomena which in early ages were explained by supernatural causes, at a later stage by abstract causes, and in these last days by relations of antecedence and consequence. This *historic* conception reveals and justifies a sixfold *scientific* classification—viz. mathematics, astronomy, physics, chemistry, biology, and sociology. Theology and metaphysics are effete, and psychology is physiology. The only object of man's true worship is humanity. Science and religion constitute positivism, based on the knowledge of the qualities of realities. Europe can only escape from anarchy by accepting this new social doctrine, which has fascinated many thinkers (*e.g.* the illustrious Littré, Dr. Robinet, and M. Rig) and issued in a philosophical school and a political party—a sort of religious sect, with a director, and a cult for the catholicization of science.

After so much unmaking and remaking of history as the French engaged in, during the Revolution and under the Empire, it is scarcely matter for marvel that a desire should arise for records of the changes time had wrought. Prior to these periods historians were scanty. Its military records had been written by Père Daniel (1649–1728); Président Henault (1685–1770) had provided a much overrated "Abrégé Chronologique;" Voltaire had composed his Essais; Abbé Velly (1709–59), Claude Villant (1717–66), and J. J. Garnier (1729–1805) wrote in succession to each other a "Histoire de France," in thirty volumes; Abbé Millot (1726–85) was frigidly voluminous, but Abbé Dubos (1670–1742) was much livelier and accurate in pre-revolutionary times. The modern historic instinct in France was awakened by Scott's "Ivanhoe." M. Augustin Thierry (1795–1856) caught the impulse: his "Histoire de la Conquête de l'Angleterre par les Normands" (1825) led the way. In his numerous works minute knowledge is combined into picturesque effects. His style is more lucid than elegant. M. de Barante (1782–1886), translator of Shakespeare's "Hamlet," revived the style and material of Froissard and Comines, and thereby took a first place among narrative writers. M. Simonde de Sismondi (1783–1841) has produced a monumental national history of France — researchful, penetrating, and learned. M. Alexis Monteil is a philosophic essayist in his "Histoire des Français des divers Etâts." The political school has M. Thiers (1797–1877) at its head. After having written his histories of (1) the French Revolution (1823–32), (2) the "Consulate and the Empire" (1845–1862), he was able to act a chief part in realizing his theories in his native land. François A. A. Mignet, Thiers' fellow-student and co-journalist, won by his vivid "History of the Revolution" a high reputation for care and judgment. He redacted many historical volumes, and his "Marie Stuart" (1851) is graphic and concise. The "Parliamentary History of the Revolution," by Buchez and Roux, is learned, but its forty volumes are wearisome and non-moral. Lives of Napoleon and histories of the Empire abound. M. Bignon is calm, dignified, and sagacious as a historical biographer of the first emperor. The resplendent poetical perfection of style which Michelet has attained makes his "History of France" fascinating, while M. Guizot's philosophic clearness and arrangement render his gracefully flowing volumes highly instructive. Armand Carrel is enthusiastic, glowing, and energetic; Count Daru, though less fervent, is animated and accurate; Capefigue favours the papacy and aristocracy; Mazure is discriminating, industrious, and thoughtful; Michaud is picturesque and poetical, but vague; and Napoleon I. is—in literature as in political life—grandiose, egotistical, but dexterously wise. Napoleon III., in this as in so many other ways, imitated the modern Cæsar, and endeavoured to compose an *apologia* for force as the foundation of French freedom, and imperialism as the immediate necessity for European stability in his (so-called) "Biography of Julius Cæsar," forgetful of the old saying, "Comparisons are odious."

In criticism, in popularized science, in the propagandism of ideas, in the production of educational works, in linguistic studies, and in expository writing generally, modern French literature merits warm praise. There are many masters in all these different departments, and France is supplied with a great variety of means for diffusing a knowledge of speculation in politics, philosophy, science, or sociology. It may be said, however, that during the present century no peculiarity of French literature is more remarkable than the *feuilletonisme* which distinguishes it in almost every form of the publication of thought.

NATURAL PHILOSOPHY.—CHAPTER XXXI.

APPARATUS DEPENDING ON INDUCTION.

THE ELECTRIC TELEGRAPH—ITS PROGRESSIVE INVENTION—FIRST ATTEMPT AT SUBMARINE TELEGRAPHY—WHEATSTONE'S FIRST ALPHABETIC TELEGRAPH—MATTEUCCI'S EXPERIMENTS ON THE EARTH'S CONDUCTIVITY—BAIN'S CHEMICAL PRINTING TELEGRAPH—SINGLE-NEEDLE AND DOUBLE-NEEDLE INSTRUMENT—WHEATSTONE'S ALPHABETIC INSTRUMENT—MORSE TELEGRAPH—WHEATSTONE'S HIGH-SPEED AUTOMATIC SYSTEM—THE TRANSMITTER, THE PERFORATOR, AND THE PRINTER—SIR WILLIAM THOMSON'S SIPHON RECORDER—DUPLEX TELEGRAPHY—DIFFERENTIAL METHOD—THE WHEATSTONE BRIDGE SYSTEM—THE DIPLEX AND QUADRUPLEX METHODS—SUBMARINE TELEGRAPH CIRCUITS—CONSTITUENTS OF CABLE CORES—APPARATUS FOR WORKING A SUBMARINE CIRCUIT—TELEPHONES, TONE AND ARTICULATING—REISS'S TELEPHONE—GRAHAM BELL'S TELEPHONE—BELL'S LATEST MAGNETIC TELEPHONE—THE GOWER-BELL TELEPHONE—EDISON'S CARBON TRANSMITTER—BLAKE'S TRANSMITTER—THE MICROPHONE—EDISON'S ELECTRO-CHEMICAL TELEPHONE—THE PHOTOPHONE—THERMO-ELECTRICITY—PELTIER EFFECTS—DIAMAGNETISM.

THE electric telegraph is an apparatus by which signals or signs can be transmitted over metallic circuits of great length, by means of voltaic currents. The invention of the electric

telegraph has been progressive, and in its present form is the result of the labours of over 100 years. As far back as 1774, Lesage in Geneva, Lomond in Paris (1787), and Ronalds in London (1816) invented systems by which signals were transmitted to some distance through wires, by observing at one end the divergence of a pair of pith balls when a charge of frictional electricity was sent into the other end. Until, however, Ampère in 1821 suggested that the motion of a galvanometer needle placed at a distant point of a circuit might serve for the transmission of signals, there was no approach towards any practical result. Schilling, Gauss, and Weber of Göttingen, in 1833, utilized this suggestion of Ampère, and employed the deflection of a suspended magnetic needle surrounded by a coil of wire to indicate a code of signals. They succeeded in sending signals by the motions of the needle (which were observed through a magnifying glass) from the Observatory to the Physical Cabinet in Göttingen, a distance of one and a quarter miles. In 1837 Wheatstone in London, and Steinheil in Munich, each produced a telegraph. Wheatstone employed five wires, each acting upon a needle, the combined motions of any two indicating the letters of an alphabetic code. In this year also Morse, in the United States, made use of an electro-magnet, the armature of which was furnished with a pen or pencil to mark a paper passed uniformly along in front of the pen, a galvanic battery at the transmitting station furnishing the power. Steinheil's telegraph was a printing and sounding apparatus, and was worked by the magneto-electric machine; only one wire was employed, the earth being used to complete the circuit. This telegraph worked through 12 miles with three stations in circuit. The introduction of the electric telegraph is therefore comparatively of recent date, as up to 1844 the state of electrical knowledge was very circumscribed, and more or less confined to lecture-table demonstrations. The discoveries of Œrsted in 1819, of Ampère in 1820, of Ohm in 1827, of Faraday in 1831, and of Wheatstone in 1843, who published in the *Philosophical Transactions* his investigations into the laws that regulate the transmission of currents through metallic conductors, were none of them developed into practical form. The two instruments working between Paddington and Slough in 1845 first attracted public attention to the real value of the electric telegraph, by transmitting to London the description of Tawell, who had been seen to enter the train at Slough after, as supposed, having committed a foul murder at Salthill. His subsequent arrest at Paddington was due to the telegraph.

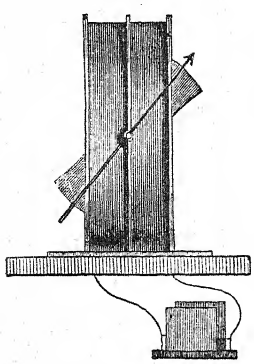
As early as 1840 Wheatstone first published his plans for transmitting messages under the sea by means of a submarine cable. That it was even then considered that this invention would lead to most important results is proved by the Abbé Moigno, who writes in 1840 that it was announced by Wheatstone that he had found the means of transmitting signals between England and France, notwithstanding the obstacle of the sea, and he emphatically adds: "I have touched with my hands the conducting wire which, buried in the depths of the ocean, will unite instantaneously the shores of England with the shores of France." In 1844, at Swansea Bay, off the Mumbles Lighthouse, the first practical experiment was carried out by Wheatstone. Signals were successfully transmitted from an open boat to the shore from a considerable distance. Between 1844 and 1848 railways were in their infancy; their limit of distance as compared with their present development was very circumscribed, and equally so was electrical knowledge as compared with the requirements of extended distance. The 5-inch astatic needles and coils of the Cooke and Wheatstone system were absolutely useless for longer distances than 100 miles, and as railways extended so telegraphic difficulties were found to multiply. In 1848, N. Holmes gave to telegraphy the practical result of his researches as regards the rapid transmission of signals over extended circuits, by which great speed was obtained. The introduction of gutta-percha in 1850, and a more perfect knowledge of the preparation of india-rubber, as developed by Hooper and Henley, have provided reliable insulators for electrical purposes, and have been the means of establishing upon a commercial basis electric communication between the chief countries of the world. Time has almost been annihilated, messages sent from India and the East arriving in London apparently hours before the time of their dispatch.

The earlier inventions of telegraphic instruments are now only historically interesting as showing the gradual advancement made towards the present complete system. In 1840 Wheatstone availed himself of the electro-magnetic property of soft iron to transmit all the letters of the alphabet and the figures which may be required in a telegraphic communication. By means of a commutator, or wheel turning on its axis, which in one revolution interrupted the current twenty-four times and re-established it twenty-four times at one station, the soft iron at the other station was in like manner magnetized and demagnetized twenty-four times. As a letter of the alphabet corresponded to each of these twenty-four alternations, and this alternate magnetization and demagnetization of the soft iron gave an oscillating motion to a small armature of soft iron, which communicated a similar motion to a wheel carrying a paper disc engraved with the twenty-four letters of the alphabet, a means was provided by which messages could be spelt out. Wheatstone afterwards made an addition by which the messages were printed instead of their being merely presented to the eye. This was effected by substituting for the paper a disc of thin brass cut from the centre into twenty-four springs, on the extremities of which types were fixed. A small hammer, actuated by an electro-magnet, impressed the type upon a sheet of manifold copying paper rolled on a cylinder and advanced automatically forward by the action of the current. This apparatus forms the basis of the beautiful alphabetical telegraphs of Wheatstone, introduced in 1860, and now largely in use both for government postal work and private wires.

Matteucci in 1844 conducted numerous experiments on the conductivity of the earth for the electric current. He employed a copper wire 9281 feet long, and circulated the current from a single Bunsen cell, which completed the circuit through a bed of earth of the same length. He found that not only did the earth offer no resistance, but that the resistance of the copper wire entering into the mixed circuit must be considered as less than that presented by the same wire when it enters alone into the circuit. Between 1841 and 1846 Alexander Bain of Edinburgh made various important improvements. Among others that known as the chemically printing telegraph, for the acquisition of which he received from the Telegraph Company £12,000. This singularly beautiful and simple arrangement is based upon the decomposition of a solution of ferrocyanide of potassium by the electric current. The message is first composed on a long ribbon of ordinary paper, which is perforated successively by small round and elongated holes, corresponding to the symbols of the Morse code, grouped together to form words and sentences. This perforated strip of paper is interposed at the transmitting station between a small metal wheel and a thin metal spring pointer in connection with the line wire, both forming part of the circuit. The wheel, in revolving, carries with it the paper strip, all parts of which pass successively between the wheel and the spring pointer. If there were no perforations on the ribbon, paper being a non-conductor, no current would pass; but in consequence of the perforations, every time a hole passes there is metallic contact between the wheel and the spring, and the current passes down the line to the receiving station, where a strip of paper soaked in a dilute solution of ferrocyanide of potassium and sulphuric acid is drawn over a metal revolving wheel in connection with the earth, a steel spring in connection with the line wire at the same time pressing upon the paper. As the current flows from the transmitting machine it is recorded in corresponding dots and dashes, printed in a blue mark, due to the formation of Prussian blue by the action of the current. Based upon Bain's principle, a very rapid form of a chemical printing telegraph has been recently devised in America. Under favourable conditions this machine has transmitted and printed intelligence between Washington and New York, a distance of 282 miles, at a speed of 1050 words, or about 5250 letters per minute, at which rate the instrument required ten perforators, thirteen copyists, and two instrument operators to keep the circuit supplied and the messages transcribed.

The telegraph apparatus now employed may be divided into two classes, non-recording or visual and oral instruments, and recording or self-registering apparatus. The single-needle and double-needle instrument, one of the early patents of Cooke and Wheatstone, is still extensively used on railways as a train signalling apparatus. Its simplicity, and the power the needle has of being *blocked* over to close a line of rail until traffic is clear, pre-eminently fit it for railway signalling. The instrument is virtually only a vertical galvanometer. An astatic or other suitable form of magnetic needle is surrounded by a coil of some 400 feet of fine copper wire wound in a frame in two connected coils for facility of replacing the needle (fig. 1). The pointer on the dial outside is simply an index. In order to send currents in either direction through the circuit, a reversing key is employed. As it is necessary that a line should be capable of being worked from either end, a battery is used at each, and the wires are so connected that when at either end a message is being received the battery circuit at that end shall be open. This arrangement is shown in fig. 3, Plate XXVI.

Fig. 1.

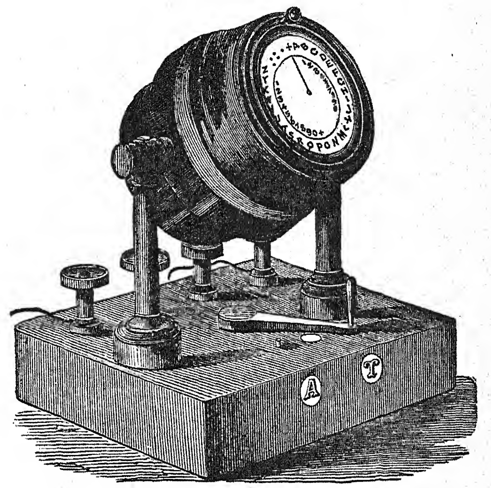


Coil and separate needle.

At one station is a battery, Z C, with one pole to earth, E, and the other pole, C, communicates with a lever key, K. On the depression of this key to transmit a current down the line, contact with the receiving instrument, G, is broken. The current flowing down the line passes through K′ at the distant station, enters the receiving instrument, G′, recording the signal by the deflection of the needle, and returns by the earth E′ to the battery from whence it started.

The single-needle instrument, except at minor railway stations, is now rarely employed for the transmission of messages, having given place to the alphabetical instrument of Wheatstone patented in 1858 and 1860. This apparatus consists of two parts, the *indicator*, for receiving the message, and the *communicator*, for sending the message. The indicator is in appearance something like a large watch placed on a small stand in any convenient position for observing the motion of the small pointer (fig. 2). The face of the dial is spaced into thirty divisions like the communicator, with its double circle of letters and figures, and its movable hand or index. A step-by-step motion is imparted to this hand by means of an electro-magnetic arrangement, which consists of two permanent magnetic bars fixed parallel to an axis, and lying between two small electro-magnetic coils with soft iron cores. These electro-magnets are so placed that when a current from the communicator passes through the coils, their armatures exercise an alternate attraction and repulsion on the poles or extremities of the two magnetic bars, the effect of which is to impart a backward and forward rotary motion to the axis. Fixed to the end of this axis is a short vertical arm, carrying a small escapement wheel of fifteen teeth, the axis of which carries the pointer on the dial. To this wheel a reciprocating motion is imparted, which is converted into rotary motion by a set of fixed stops or pins, against which the teeth strike. The stand of the indicator is provided with a lever turnplate, by which the alarum A, for calling attention, or telegraph T can be thrown into circuit. All the moving parts of the indicator are of extreme delicacy, almost as fine as watchwork, and momentum and friction are thereby minimized. The communicator consists of a small box with a fixed dial having its circumference divided into thirty equal spaces, marked with the twenty-six letters of the alphabet, the three points

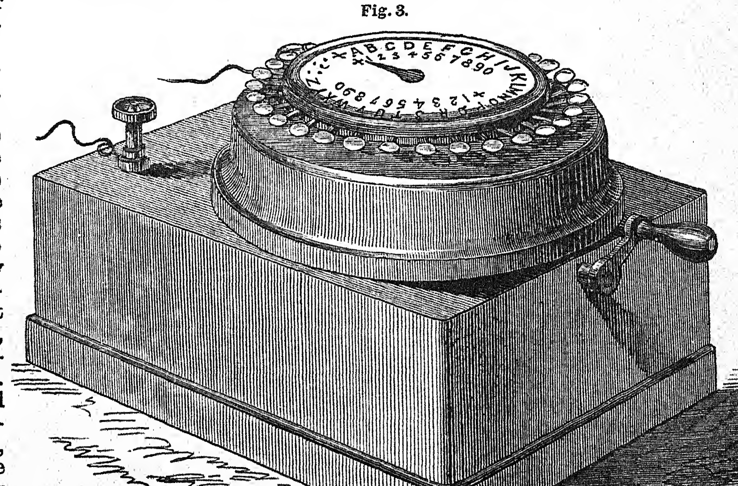
Fig. 2.



The Indicator.

of punctuation, and a +, with an inner circle marked with the nine digits and a +, the numerals being repeated twice. A hand or pointer in the centre of the dial rotates by mechanism, and points, at the will of the operator, to the letters or figures required to be indicated. Round the circumference of this lettered disc are thirty small keys or buttons, which can be depressed by the finger, one for each letter or sign. In its interior construction the box contains a permanent horse-shoe magnet with four fixed coils of insulated wire for producing the necessary magnetic currents. An exterior handle, on being turned by the hand, causes an axis carrying

Fig. 3.



The Communicator.

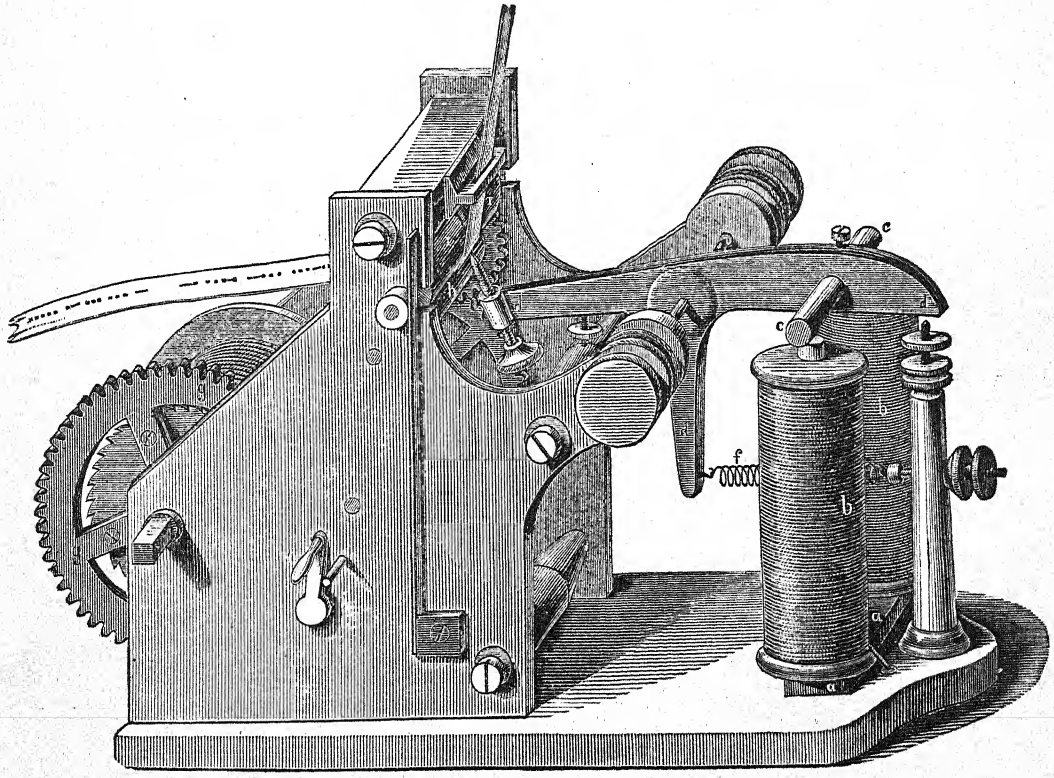
a soft iron armature to revolve in close proximity to the soft iron cores of the coils on the poles of the magnet, so that at every revolution of the handle the soft iron armature passes over the poles of the magnet, and at the moment of making and breaking contact, induces currents of electricity, moving alternately in opposite directions through the wire of the coils, if the circuit be complete. A constant succession of

currents of electricity is therefore obtained by the continuous revolution of the handle.

The mechanism of the communicator is so arranged that when any one of the thirty keys is pressed down by the finger, that key has the effect of cutting off the passage of the current along the line and through the instrument, and of making a short circuit with the earth so long as it remains depressed. When any other key is similarly depressed, a simple piece of mechanism, in the form of a slack endless chain, causes the depression of this key to elevate the former key, open the electrical circuit, and allow the induced currents derived from the magnet to flow in succession through the instrument and along the wire to the distant station, until they are again interrupted and pass into the earth by the depressed key. This short-circuit contact is made by means of a loose carrier arm attached to the axis which carries the pointer on the dial, and thrown in or out of gear by the depression or elevation of a key. Motion is communicated to this axis by a bevelled wheel working into a pinion fixed to the axis carrying the armatures, the motion being so adjusted that for every separate current induced in the coils the hand shall move one space or letter on the dial. The keys therefore being depressed in succession will each liberate one current, or thirty distinct currents during an entire revolution of the hand round the dial, fifteen in one direction and fifteen in the opposite direction. For each current transmitted the hand of the communicator and those of the indicators at the near and distant station will simultaneously advance one step until the letter opposite the depressed key is reached by the pointer. A short circuit is then made by the carrier; the current no longer flows through the telegraph wire and indicators, but passes into the earth so that the pointers come to a stand opposite that letter and remain until another key is depressed and the circuit is again opened. This invention of Wheatstone's is especially useful because it requires no skill on the part of the operator either in manipulation or in reading, and is always in readiness for immediate use by the employment of the magnet in place of voltaic batteries. It has been most extensively employed in private wires and by the Postal Telegraph Department on short circuits. The general introduction of the telephone has partly displaced it, as speaking the message is always more rapid than spelling it; but so few persons possess the power of clear and distinct pronunciation that in many instances communication by telephone is actually less rapid than by the Wheatstone A B C instruments, which are capable of sending more than 100 letters per minute.

The Morse telegraph, which marks or inks the message upon a ribbon of paper, is almost universally adopted in this country for ordinary hand transmission, as it is also throughout the world. The apparatus as now constructed is one of extreme accuracy and simplicity, and for long circuits is generally worked by the "relay" system. It consists of three parts, the indicator, communicator, and the relay. The principle of the apparatus will be understood by reference to the annexed engraving (fig. 4), which shows its simplest form. The current enters the indicator by the

Fig. 4.



line wire and passes into the two electro-magnets, *b b*, fixed to the soft iron piece, *a a*, which, when the current is closed, attracts an armature, *c c*, of soft iron fixed at the end of a horizontal arm, *d d*, movable about an axis; when the circuit is interrupted the arm is raised by a spring, *f*, the tension of which can be regulated. The amplitude of the motion of the soft iron armature, *c c*, is also capable of adjustment; the other end of the lever may carry a small pointed style for embossing the paper by upward pressure as the ribbon passes over a small roller, *i i*, with a groove cut in the circumference to receive the point, *h*, of the style. This class of Morse instrument is termed an "embosser." In the most recent form the Morse instrument is arranged as an "ink-writer," in which the attraction of the armature downwards lifts a little wheel supplied with ink by contact with a revolving inking roller and pushes it against the paper ribbon. If the current is momentary it prints simply a dot; if the current continues to flow for a longer time the ink wheel records a dash; if the current is continuous the ink wheel records a continuous black line. The Morse code, or alphabet of dots and dashes, is given annexed. The instrument is sometimes arranged as a "sounder," in which case the

operator who is receiving the message listens to the clicks of the armature and observes whether the intervals between them are long or short, writing down the message at the time the ear translates the sequence of sounds.

Fig. 5.

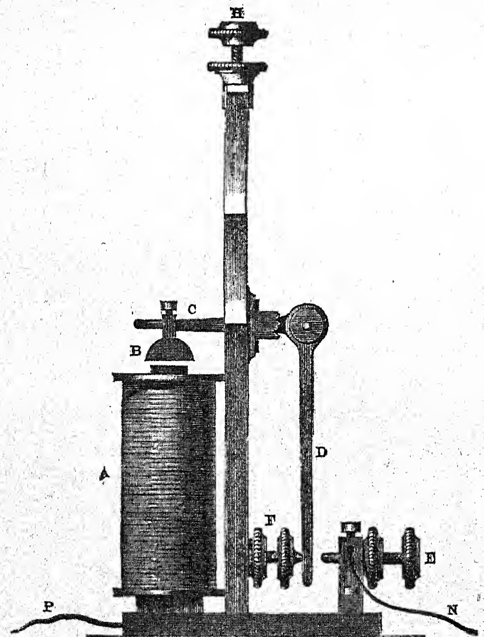
a	· —	p	· — — ·
ä	· — · —	q	— — · —
b	— · · ·	r	· — ·
c	— · — ·	s	· · ·
d	— · ·	t	—
e	·	u	· · —
é	· · — · ·	ü	· · — —
f	· · — ·	v	· · · —
g	— — ·	w	· — —
h	· · · ·	x	— · · —
i	· ·	y	— · — —
j	· — — —	z	— — · ·
k	— · —	ch	— — — —
l	· — · ·	Full stop	· · · · · ·
m	— —	Repetition	· · — — · ·
n	— ·	Hyphen	— · · · · —
o	— — —	Apostrophe	· — — — — ·
ö	— — — ·	Finish	———————

The Morse Alphabetical Code.

Where there are a number of instruments working in one circuit or in transmission over long lines, the currents are frequently too feeble to work the recording instrument directly without the interposition of a relay or repeater, which responds to the original current, and in so doing brings into action a strong local current to work the instrument. The principle of the relay is an electro-magnet, A (fig. 6), round which the line current flows, attracting the delicately poised armature B, after which it either passes to earth in the case of a terminal instrument or continues to flow down the circuit to the next relay station.

The armature B carries on its axis of motion the bent arm, D, which oscillates between the two points F, E, the distance

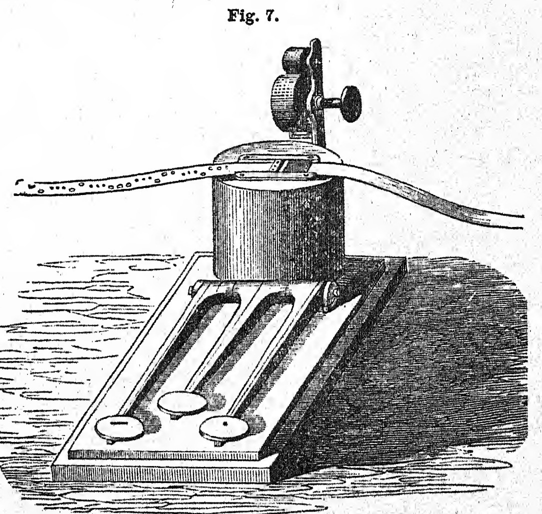
Fig. 6.



of which can be adjusted by a screw, E. A delicate coil spring attached to the arm C, the tension of which is regulated by the screw H, serves to restore the armature B to its normal position when no current passes through the electro-magnet A. The receiving instrument is connected in circuit with the local battery, one pole of which is attached to the relay by the wire N. The other pole of the battery, the receiving instrument being in circuit, is attached to the relay by the terminal P. On the armature B being attracted the arm D, in metallic connection with P, makes contact with E, and the local battery circuit is closed, the receiving Morse indicating the duration of the current. Thus the relay transmits to the indicator exactly the same sequence of currents and intermittences as those despatched by the manipulator in the station which sends the despatch. The key or transmitter is simply a lever working on a horizontal axis in its middle. One end of this lever is always pressed upward by a spring, so that the other end is in contact with a metal button to which the wire from the indicator is attached. The lever itself is in metallic contact with the line wire. A second metal button under the opposite end of the lever is in communication with the local battery. By depressing this end of the lever with the hand contact is made with the battery, the current passing down the line to the distant instrument or relay, and at the same time that the current is sent down the line, contact with the receiving instrument at its own end is broken. According to the length of time during which the key is depressed a dot or a dash is registered on the receiving instrument to which the current travels.

The great problem of mechanical telegraphy is to obtain the greatest amount of work out of a wire in a given time. This speed is regulated by the rapidity with which currents of electricity can be transmitted through the wire without coalescing, that is, without interfering with each other and running together to form a continuous line at the distant end. In the high-speed automatic transmitter Wheatstone has made use of the principle of the Jacquard loom. The currents are passed into the circuit at equal intervals of time and of equal duration, conditions essential to be observed when high-speed transmitters are to be employed. Wheatstone's mechanism consists of three distinct parts: (1) the *perforator*, for the preparation of the paper strip which regulates the succession of the currents; (2) the *transmitter*, for passing the currents so grouped into the circuit; (3) the *printer*, by which the currents so passed into the line are recorded and converted into symbols representing letters, words, and sentences. The message to be sent is first punched out in holes

Fig. 7.

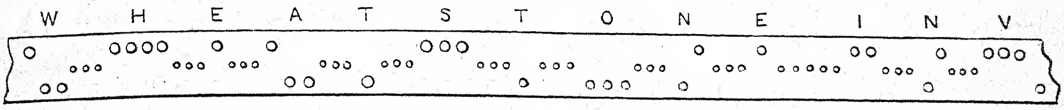


The Perforator.

arranged to represent the dot and dash of the Morse alphabet, on a continuous paper ribbon by means of the perforator, shown in fig. 7 in a simple form. Each of the three finger lever keys on depression perforates a small round hole in the paper ribbon; that on the right being representative of the dot, the left of the dash, and the centre key the mechanical spacing of the holes necessary to ensure the regular motion of the perforated ribbon through the transmitter. The perforator is so arranged that on the depression of any one of the keys a threefold action takes place: (1) the

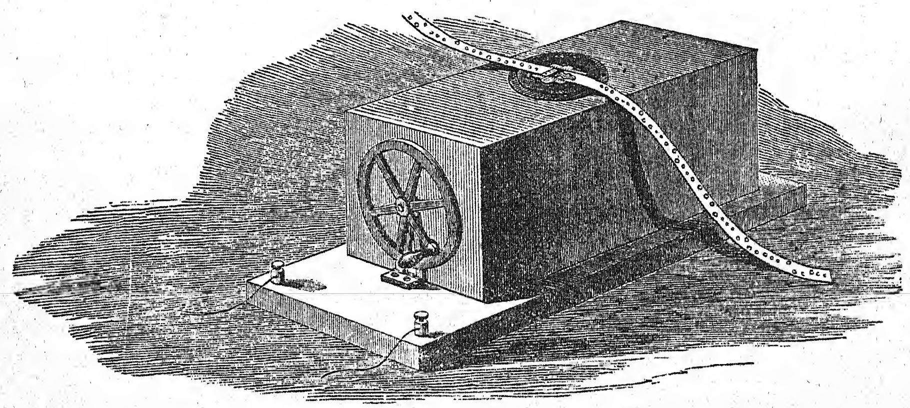
paper ribbon is locked fast in the machine to receive the perforation; (2) the hole is cut by the pressure of a steel pin on the ribbon; (3) a mechanical movement or rocking frame, which at first holds the paper in the direction in which the ribbon enters after the hole is cut, automatically carries it forward the requisite distance to receive the next perforation. The centre punch, besides mechanically spacing the perforations, also spaces the distance between the letters and words of the message. A paper ribbon perforated with the words "Wheatstone inv." is shown full size in fig. 8. Thus the

Fig. 8.



message is prepared apart from the wire, and the time occupied in its preparation is independent of the employment of the circuit. The *transmitter* (fig. 9) is the apparatus which automatically sends into the circuit the sequence of currents as prepared by the perforator. The perforated ribbon paper is caused to advance step by step through the machine by the successive grip of an oscillating cradle regulated to advance the paper a distance exactly corresponding to the spacing of the centre holes by the action of a rising pin, elevated and depressed alternately at each to and fro motion of the rocking frame. Two other spring contact pins, connected respectively with the + and − poles of the battery, are actuated by the same mechanical movement. The perforated paper ribbon is carried forward step by step by the action of the central pin, and if a current-passing perforation is in position at the moment of passing the paper ribbon over either contact pin, this pin will rise through the hole and make a metallic contact with the battery through the instrument, sending a current into the line in the one or other direction, according to the position of the perforation on the ribbon. When no perforation is in position at the time of the rising of the contact pins, no current from the battery

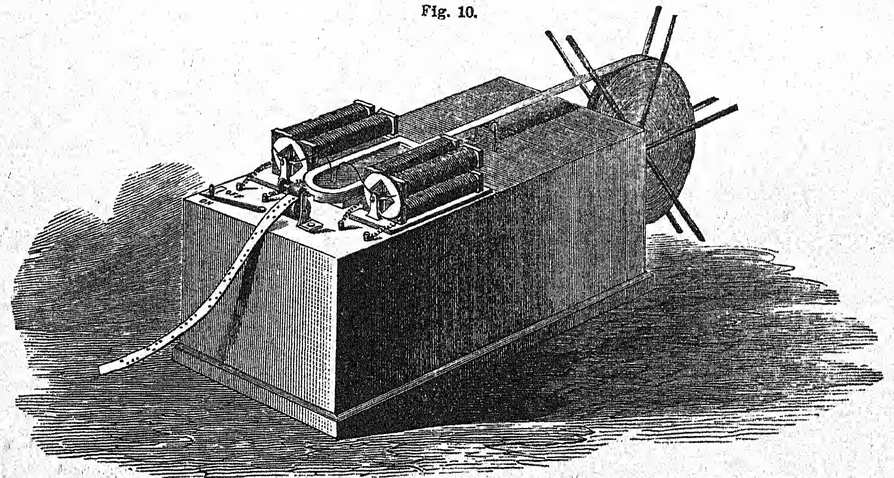
Fig. 9.



The Transmitter.

passes into the circuit. A fourth important electrical contact movement takes place at each successive motion of the rocking cradle independent of the rising of the pins—namely, that of momentarily making contact between the line wire and the earth after each elevation of either contact pin. This discharge to earth is necessary to clear the line from the portion of the transmitted current retained in the insulated wire, which, unless drawn out, would interfere with the integrity of the succeeding current. The currents thus rapidly passed into the line wire by the transmitter are automatically re-

Fig. 10.

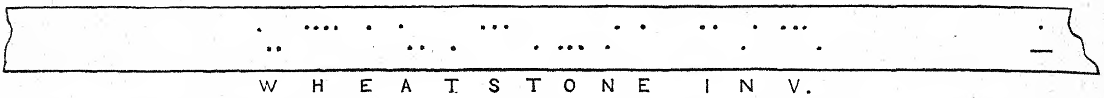


The Printer.

corded at the distant station by the receiver or printer, which marks upon a continuous paper ribbon, as it passes through the instrument, a series of dots corresponding to the holes in the perforated Jacquard ribbon, as rapidly as the sequence of currents can be passed into the line. Two forms of this receiving instrument will be noticed; one is shown in the annexed cut (fig. 10), in which the dot-and-dash code is represented by dots upon the paper ribbon upon each side of a

central line, the lower line of dots being read as dashes, and the upper line as dots. The paper ribbon mechanically advances forward through the machinei n a uniform manner, and is passed under a shallow dish containing ink or other marking fluid. Two fine holes are made through the bottom of this reservoir, in a position to correspond with the dots to be printed upon the ribbon as it passes underneath the reservoir. By reason of capillary attraction the ink is prevented from passing through these apertures. Two electro-magnets, one on each side of the ink reservoir, actuate two needles, which are so adjusted that when they are depressed by the action of the current they dip into the reservoir, the ends passing into the holes and carrying a small dot of ink on to the paper ribbon. The mark thus printed represents a dot or dash, according as one or other needle is depressed without any friction or mechanical resistance beyond that of the needle dipping into the ink. The electro-magnet coils are so arranged that only one of the needles is acted upon by currents as they flow from the + or − poles of that battery. The dot, perforation, and printing is shown in fig. 11 full size.

Fig. 11.



In the other form of printer the Morse code is printed in dot-and-dash characters. Capillary attraction is again made use of in a different manner. A small metal inking disc mounted upon a delicately poised axle capable of a slight oscillation in a lateral direction, according as it is influenced by the to-and-fro motion of a permanently magnetic armature when acted upon by the alternate currents passed into the line from the transmitter, is caused to rotate rapidly by the same mechanical power that advances the paper ribbon. This small rotating inker is placed close to the surface of the paper ribbon, so that on receiving a lateral motion in one direction its edge is pressed against the paper and removed from it by an opposite motion, while in its normal position it is free from contact. Thus contact with the paper will produce marks—either dot or dash—according as the contact of the inker is momentary or of a sensible duration, the contrary movement producing the spacing between the printed symbols. As the currents from the Jacquard ribbon are passed into the line at equal intervals and in alternate directions, the spacing between the signals will be automatically regular, the dash being the effect of the retention of the magnetic armature acting upon the inking disc for double the time of the dot, by reason of the grouping of the perforations to form the dash, giving a longer duration of current without a reversal. This high-speed printing telegraph of Wheatstone's is extensively employed upon the postal telegraph wires for the transmission of press news and telegraphic despatches. The one perforated ribbon can be passed successively through a series of transmitters each in connection with a different circuit—north, south, east, or west—each station or series of stations receiving the intelligence at the same time, as the one perforated ribbon passes in succession through the respective transmitters. In order fully to realize the great value of the automatic high-speed system upon extended lines of telegraph, it is only necessary to compare the speed of the Morse apparatus on lines of a given length with that of Wheatstone's instrument. From the speed of the transmission it becomes necessary to adopt a special system for despatch and receipt of intelligence. Messages are therefore passed into the machine for transmission along the wire in groups; thus twelve messages will be perforated on a continuous ribbon and sent through the transmitter at the same time, and *vice versâ*. Thus with a wire of a known capacity, and on a circuit of (say) 300 miles, four distinct groups, each consisting of twelve messages of thirty words each, can be forwarded, and three similar groups received in an hour—equivalent to eighty-four messages of thirty words each, with an average of five letters to a word, or a total of 12,600 letters, or about 210 letters per minute, representing forty-two words a minute, with all the necessary code formalities and acknowledgments in addition. When transmitting parliamentary and newspaper despatches a much higher speed can be obtained, as there is no grouping and the transmissions are always in one direction down the line, either as wholly received or forwarded messages. The average speed attained between London and Aberdeen is forty words; Edinburgh, Glasgow, and London, fifty words; Newcastle and London, sixty words; London, Liverpool, and Manchester, 120 words. The shorter the length of line the greater the speed obtained.

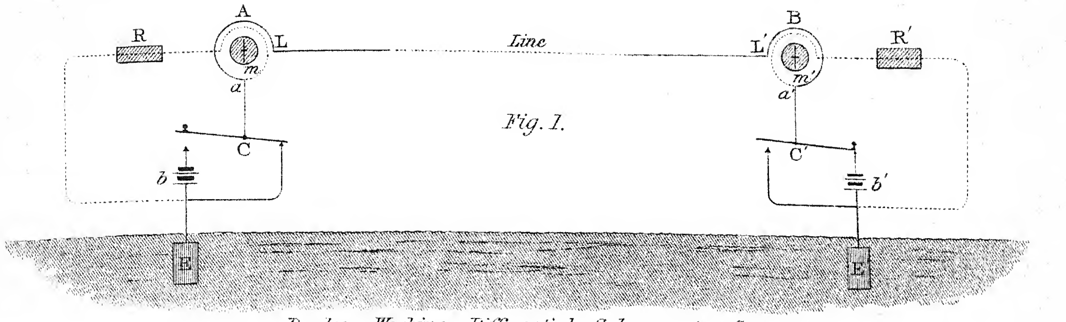
This system of Wheatstone's pointed out the path to other inventors, and both Sir William Thomson and Messrs. Siemens have introduced somewhat similar apparatus. The *siphon recorder* of Sir William Thomson enables extremely feeble currents transmitted through long lengths of submarine cables to be observed and recorded. In its principle it is exactly the converse of the reflecting galvanometer, for here the coil is movable and the magnet fixed. The principle of its construction is as follows:—The receiving instrument consists of a light flat coil of a small number of turns of fine wire in connection with the line wire, which is suspended by two silken fibres between the two poles of a very powerful horse-shoe magnet, either permanent or electro-magnetic, which acts with great force on the coil when the current passes through it. When no current passes, the plane of the coil is in the right line joining the poles. When a current passes, the coil, becoming thereby a magnet, is deflected either to the right or the left, according to the direction of the current. The inking apparatus consists of a very light capillary glass tube, bent into a siphon form, and connected with the coil by a system of delicate silk threads. The short leg of the siphon dips into a reservoir of ink, while the long leg hangs in front of a continuous paper ribbon, which is moved along at a uniform rate after the manner of the Wheatstone and the Morse ribbons. On the ink in the reservoir being electrified, so that a powerful difference of potential is maintained between the siphon and the metal plate over which the paper is passing, a fine stream of ink, or rather a succession of minute dots of ink, is spirted from the siphon on to the paper, leaving a record of the position of the tube at each instant, and drawing a continuous line on the paper without impeding by friction the motion of the tube as directed by the receiving coil. This line is either straight when no current passes, or diverges to the right or left, according as the coil is deflected to the right or left. Thus the dot and dash of the ordinary telegraphic code may be symbolized. The electrification of the ink is effected by a small electrostatic induction machine, worked by the same motor which propels the paper ribbon. The messages for transmission are perforated on a paper strip after the manner of the Wheatstone apparatus.

Duplex telegraphy is the art of telegraphing simultaneously in opposite directions on the same wire. This was first performed by Dr. Gintl in 1853. Circuits worked on the duplex system are largely employed in the United Kingdom, United States, and elsewhere. Various plans have now been devised for carrying out this important arrangement. One of these plans may be termed the *differential* method, in which the instruments are wound with differential coils; the other the *Wheatstone bridge* method, which is capable of more general application. In the differential method, let m (fig. 1, Plate XXVIII.) represent the electro-magnet of a Morse apparatus, which is wound round with two equal coils in opposite directions. These coils are severally represented by the continuous and the dotted lines. One of these coils, which may be called the line coil, is connected to the line L L′, which joins the two stations A and B together. The other coil, represented by the dotted line, which may be called the equating coil, is in connection with the earth at E by means of an adjustable resistance or

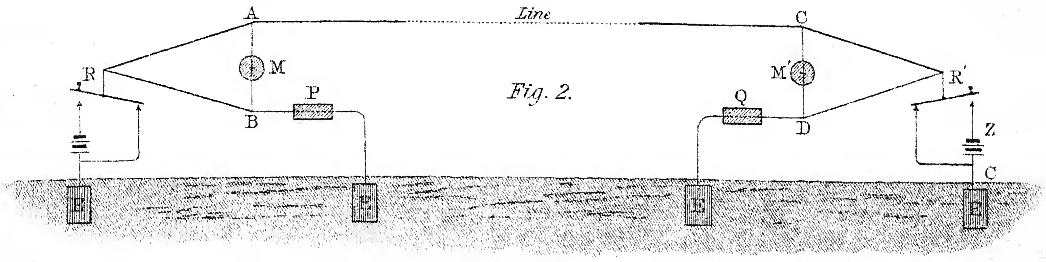
NATURAL PHILOSOPHY.

PLATE XXVIII.

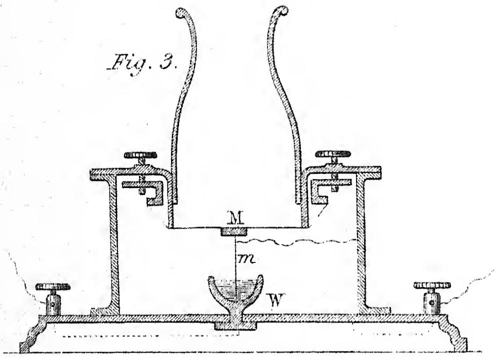
DUPLEX TELEGRAPHY TELEPHONES MICROPHONES



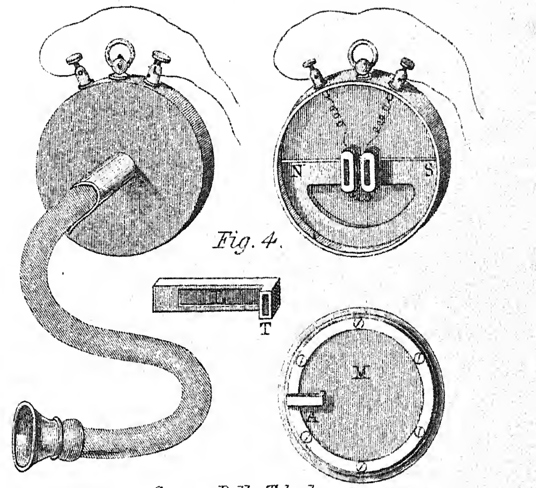
Duplex Working; Differential Galvanometer System.



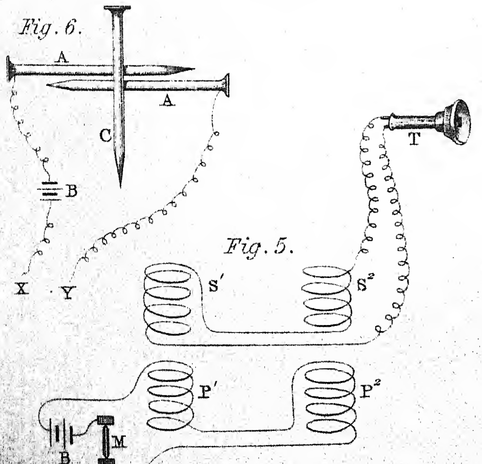
Duplex Working on Bridge System.

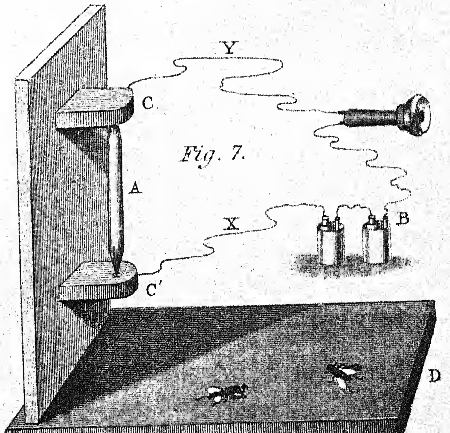


1. Section of Gray's transmitter.
M. membrane. m. platinum wire. W. vessel of water completing the circuit.



Gower-Bell-Telephone.
A. mouthpiece. M. metal diaphragm. N.S. magnet. L.T. reed call-signal.





Carbon Microphone.

artificial line, R. The resistance of the circuit a R E can therefore be accurately adjusted to be equal to that of the circuit a L L′ a'. The battery b has one pole in connection with the earth at E, and the other pole, by means of a make and break key, c, can be connected at a, where the two oppositely wound coils bifurcate. The back contact of the key is likewise connected with the earth.

The station B is arranged in a precisely similar manner. When station B depresses his key and sends a current into the line, as the electro-magnet of his Morse instrument is wound with equal coils in opposite directions, the effect of the two currents which separate at a' will be to neutralize one another, and the armature is not attracted. Consequently, although a current passes from B down the line to A, there is no movement in his own instrument—an essential condition in all systems of duplex telegraphy. This transmitted current arriving at A will be subjected to two different paths, according to whether a message is or is not being forwarded from A at the same time. If the instrument key at A is not down, then the current will circulate round the core of the electro-magnet, and will reach the earth by the path L a c E, the core becomes magnetized, the armature is attracted, and a signal is produced in the ordinary way. Should, however, the key at A be depressed at the precise moment at which B has his key down, then, as currents are sent in opposite directions from both A and B at the same time, they neutralize one another, and no current passes in the line a L L′ a'; it is, as it were, blocked. But though no current passes in the line coil, a current passes to earth at each station through the equating coil, which being no longer counterbalanced by any opposite current in the line coil, magnetizes the core of the electro-magnet, the armature is attracted, and a signal produced. It is immaterial whether A and B send currents of opposite kinds into the line at the same time, for though they neutralize each other in the line circuit L L′ the effect is the same as if the resistance of the line were reduced; more electricity flows from each station through the line coil, it being no longer balanced by the equating coil, so that the current of the line coil preponderates and works the electro-magnet. Therefore in each case each station produces the signal which the other station desires to send.

In the Wheatstone bridge system the circuit is divided at R (fig. 2, Plate XXVIII.) into two branches, which go by A and B respectively, the one to the line, the other through an adjustable resistance, P, to the earth, E. If the ratio between the resistances in R A and R B is equal to the ratio of the line and of P, then, according to the principle of Wheatstone's bridge, *no* current will pass through the instrument M. Although M does not give indication of any currents sent from R, the instrument M′ at the distant station will show them, for the current on arriving at C divides into two parts, one of which flows round to the earth by R′, the other part traversing M′ and producing a signal. Should the operator at R′ depress his key at the same instant and transmit an equal current down the line in the opposite direction, the flow through the line will cease as the currents neutralize each other, but the instrument M will now show a signal, because, although no current flows through the line, the current in the branch R A will now flow down through M, as if it had come from the distant R′; consequently, whether the operator at R be signalling or not, the instrument M will respond to the signals sent from R′.

The *diplex* method of working a circuit consists in sending two messages at once through a wire in the same direction. For this purpose it is necessary to employ instruments which work only with currents in one given direction. This method therefore necessitates the employment of relays, in which the armatures are themselves permanently magnetized or polarized, and which therefore respond only to currents in one direction.

The *quadruplex* method of working combines the duplex and the diplex methods. On one and the same circuit are employed two sets of instruments, one of which, working by a polarized relay, is only actuated when the direction of the current is changed, the other, worked by a non-polarized relay adjusted with springs to move only with a certain minimum force, works only when the *strength* of the current is changed and is independent of its direction. The chief difficulty in duplex and diplex working is the continual variation in the resistance of the line-wire itself, arising from imperfect insulation, variations of temperature, &c.; and in such a changeable climate as that of Great Britain these circumstances limit the distance on land lines in which a duplex system can be worked with advantage. As the variations in the resistance of submarine cables is practically very small, duplex telegraphy is specially applicable to such circuits, their electrostatic capacity being balanced by condensers.

In submarine telegraph circuits the essential parts of the circuit are the conductor, the insulator, and the external covering to provide tensile strength. In connection with submarine circuits, several matters of great importance have to be considered. The capacity of the copper conducting wire has to be determined according to the length of the circuit. Too small a conducting wire on a circuit of a given length would offer too great a resistance, while too large a conductor would, from its large superficial area, increase the induction in greater proportion than its increased sectional area augments the speed. The precise sectional area of the wire has therefore to be determined. Again, the best relative proportion in weight and sectional measurement between the wire and that of the insulating material must be calculated. Insulation may be obtained by a mere film of a non-conductor surrounding the wire. This is demonstrated by passing a weak voltaic current of electricity through an extended fine metallic wire immersed in water. By the action of the current through the wire the water in immediate contact with it is decomposed, and a fine non-conducting film of hydrogen is developed surrounding the wire, which, with a strength of current adjusted to the resistance of the wire, will separate the water from the metallic conductor, perfect insulation being maintained. Destroy the balance between the current and the wire, and the hydrogen, evolved too rapidly by reason of electrical decomposition, accumulates upon the surface of the wire, and passing off in the form of small bubbles destroys the insulation. In practice a certain thickness of insulation is absolutely necessary for security. The conditions which regulate the absolute and relative sizes of the constituents of cable cores are as follows:—The dimensions of the core are determined by the number of words per minute required to be transmitted, and by the total length of the cable. The number of words which a core will transmit in a given time, if the ratio between the weights of the conductor and insulator be maintained constant, is directly as the weight of the core, it varies with the nature of the insulator, and is inversely as the square of the length of the cable. The ratio between the weights of the insulator and conductor per mile is varied with the *specific inductive capacity* of the insulating material employed, and as a rule the insulator is used in excess of the weight indicated by theory as necessary to give the maximum speed with a given diameter of core. With gutta-percha cores the ratio of copper to gutta-percha by weight varies from two-thirds to equality. The lightest core in use has 73 lbs. copper and 119 lbs. of gutta-percha per nautical mile. The largest core yet laid, that of the French Atlantic cable, is 400 lbs. copper and 400 lbs. gutta-percha. The diameter of this conductor is ·168 inch, and of the core ·470, or the ratio of the diameters is nearly 1 to 3. The specific inductive capacity of india-rubber being much lower than that of gutta-percha, a thinner covering of this material is required to obtain a given speed through a fixed conductor, and therefore in an india-rubber core the copper bears a larger proportion by weight and bulk to the insulator. As a certain absolute thickness of insulator is necessary mechanically, in a small core of Hooper's or Henley's india-rubber 90 lbs. of copper and 130 lbs. of insulator per mile are used, the diameters of copper and core being ·080 and ·241 inch respectively, or as 1 to 3. A medium-sized core has equal weights—namely, 180 lbs. of each per mile; in larger sizes the copper is always in excess; thus the North China cable between Hong-Kong and Shanghai has 300 lbs. copper to 200 lbs. insulator, the diameters being respectively ·147 and ·318 inch. Hooper's and Henley's insulator is about 2·25 per cent. heavier specifically than gutta-percha.

The number, n, of words per minute a given gutta-percha core L miles in length, the conductor weighing w lbs. per mile, will transmit with a mirror instrument, is represented by the formula $n = c\,\frac{w}{L^2}$; c being a coefficient varying with the ratio between the gutta-percha and copper. The values for c for several ratios are given annexed, the weight of copper being 100:—

Weight of Gutta-percha.	Value of c.
80	163·000
90	175·000
100	187·000
110	196·000
120	205·000
130	21·500
140	22·400
150	23·300
160	24·000

If the Morse instrument is used, n is to be divided by 14; if Hooper's or Henley's insulating material is used, n is to be multiplied by 1·17. As the strength of a cable depends upon the external protecting sheath, it is usually protected with iron or steel covered wires. This outer covering of the cable is varied with the depth to which the cable has to be laid, and its liability to disturbance by tides, currents, and friction against rocks, &c.

When a current is sent through an Atlantic cable from Ireland to Newfoundland no effect is produced on the most delicate instrument at the receiving end for two-tenths of a second, and it requires three seconds for the current to gain its full strength, rising in an electric wave which travels forward through the cable. The strength of the current falls gradually also when the circuit is broken. The greater part of this retardation is due to electrostatic charge, not to electromagnetic self-induction; the retardation being proportional to the square of the length of the cable. The cable in its insulating sheath immersed in water, acts like a Leyden jar of enormous capacity, and the first portions of the current, instead of flowing through, remain in the cable as an electrostatic charge. For every separate signal the cable must be at least partially charged and then discharged. The general arrangement of apparatus for working a submarine circuit is shown in Plate XXV., fig. 11, in which is seen the battery, consisting of a series of cells of Daniell's arrangement; the contact keys for passing the + and − currents into the cable; the switch placing the cable in connection either with the earth, instrument, or battery, as required; B, a form of Thomson's reflecting galvanometer placed in connection with the cable by the switch; the magnet arrangement, E, for steadying and adjusting the coil mirror; resistance coils interposed into the circuit between the instrument and the earth; a switch for connecting the line to earth; and a darkened recess to receive the scale upon which the spot of light reflected from the lamp situated behind the partition, the ray from which, passing through a slit in the direction R, is reflected back from the galvanometer mirror in the direction R′. A section of the coil of the mirror-galvanometer is given on an enlarged scale in fig. 12, showing how the minute mirror and magnet are suspended. The passage of a current through the coil deflects the magnet and thus causes the mirror to move, the reflected spot of light moving through a much greater distance.

As an example of the value of delicate recording apparatus in augmenting the speed upon a submarine circuit, upon the Great Northern Company's cable between England and Denmark, 365 nautical miles in length, with the most improved submarine Morse an average of seventeen words a minute was obtained, with the Wheatstone's automatic printer thirty-three words, and with the Thomson siphon recorder fifty words per minute are practically realized. Every submarine cable requires to be laid with a certain percentage of slack, regulated according to depth of water and surrounding circumstances. The average slack is from 8 to 14 per cent., though for very great depths, of 2000 fathoms or so, 20 to 25 per cent. is not excessive.

TELEPHONES.

The telephone is an instrument by means of which a sound, a noise, a melody, a song, or any utterance of the human voice can be transmitted to a distance. Telephones may be divided into two classes—*tone* telephones, which only transmit musical sounds; and *articulating* telephones, which transmit the intonations of the human voice. The tone telephone dates back as far as 1837, when Page, an American, discovered that rapid changes of magnetization of iron bars produced sounds which he termed galvanic music. The sound emitted by the bar depended upon the number of changes produced in a second. Sixteen at least were necessary to produce a defined sound. In 1843 De la Rive, of Geneva, increased the effects of Page's vibrations, by employing wires of great length arranged in coils. In 1855 Leon Scott, of Martinville, invented an instrument, consisting of a stretched piece of skin vibrating under the influence of the voice. This instrument was designed as a graphic representation of vibrations, and is the origin of the vibrating plate of the telephone. In 1860 Reiss produced an apparatus by means of which a melody produced in one place could be transmitted to a great distance. In this instrument the voice was caused to act upon a point of loose contact in an electric circuit, and by bringing those parts into greater or less closeness of contact, varied the resistance offered to the circuit. The transmitting part of Reiss's telephone consisted of a battery and a contact breaker, the latter being formed of a stretched membrane, capable of taking up sonorous vibrations, and having attached to it a thin elastic strip of platinum, which, as it vibrated, beat to and fro against the tip of a platinum wire, thus making and breaking contact wholly or partially at each vibration. These vibrations were exactly synchronous with those of the membrane, and consequently with those of the voice or the instrument playing the tune. Thus not only was time kept, but also tune—the two factors which constitute melody—pitch, and interval were automatically reproduced. The receiving part of the instrument consisted of an iron wire fixed upon a sounding-board, and surrounded by a coil of insulated wire forming part of the circuit. The rapid magnetization and demagnetization of the iron core produced audible sounds, and since the pitch of a note depends only on the frequency and not on the form or amplitude of the vibrations, the pitch of a note sung into the transmitting part was reproduced. If the current vary less abruptly, the iron wire is partially magnetized and demagnetized, giving rise in turn to vibrations of varying amplitudes and forms. Such a wire would therefore serve perfectly as a receiver to reproduce speech if a good transmitter is used. It cannot be doubted that Reiss's instrument can reproduce articulate speech; it may not have done so before the invention of the Bell telephone, but there is some evidence that the Reiss instrument did produce articulate speech in 1862. Reiss must be considered as the first inventor of an instrument for producing undulatory currents in a closed circuit, the first to use undulatory currents to reproduce sounds with the assistance of the voltaic battery, and the first to invent an instrument capable of reproducing articulate speech though not intended for that purpose. It is, however, one thing to make a great discovery, and another thing to know how to utilize it and make it practically and commercially successful. Reiss, the workman, without realizing the greatness of his discovery, died poor, as he had lived, in 1874; and two years after, in 1876, Graham Bell had the good fortune to announce to the world his speaking telephone, in which the principles of the Reiss receiver are embodied in an instrument in which the bar armature of the Reiss is changed into a circular armature. Graham Bell's telephone, patented 14th February, 1876, effected by a method of marvellous simplicity the electric transmission of articulate speech to a distance. It was first exhibited at the Philadelphia Exhibition, 1876, where the invention met with almost universal incredulity; the people would not believe the evidence of their ears.

The first telephone that transmitted the voice, the string telephone, was invented more than 200 years since. It consists of two cylindrical tubes of thin metal or cardboard, one end of each being closed with a stretched membrane of

parchment or thin cardboard. The two vibrating sheets thus formed are then connected by a string fixed in their centre by a knot. When the string which joins the two tubes is stretched, and not too long, words are transmitted by the string with great clearness. There is here therefore a mechanical transmission of vibrations and a synchronal movement of the two membranes. Helmholtz's researches on the synthesis of sounds prepared the way for the final invention of articulating telephones. Bell's first transmitter was formed by an electro-magnet, E (fig. 1, Plate XXIX.), and a vibrating membrane, M, on which were placed, as a sort of armature, watch springs of the size of a thumb-nail. The tube S was for speaking into, and to confine the vibrations. The terminals *a b* are in connection with the coil wire of the electro-magnet E. The receiver (fig. 2) was formed of a tubular Nickle's electro-magnet, E, on which was fixed with a screw, *a*, a slight armature of sheet iron of the thickness of a strong piece of paper, which acted as a vibrator. The apparatus thus constituted was not an electro-magnetic telephone, a battery of several elements being placed in the connecting circuit of the two instruments. The receiver, therefore, could not serve as a transmitter; consequently, two distinct instruments were required at each station. On 12th February, 1877, Bell exhibited at Salem, Massachusetts, the first magnetic telephone in which a permanent magnet was employed as a magnetic core, and articulate speech was conveyed by its means to Boston, 14 miles distant. Before describing the telephone as now employed, it is only justice to name the part which Elisha Gray has taken in the invention of the instrument. By a remarkable coincidence, of which an instance has already been referred to with reference to the discovery of the principles of dynamo-electricity, Bell and Gray both lodged their patents on the same day, 14th February, 1876, and both called attention to the importance and necessity of employing undulating currents for the electrical transmission of speech or combined sounds. In the apparatus patented by Gray the undulating currents required for telephonic transmissions were obtained by varying the electrical resistance of the circuit, and consequently the intensity of the current in this circuit. Both Bell's and Gray's speakers are identical as regards principle, and similar as regards construction.

Gray's transmitter (fig. 3, Plate XXVIII.) is shown in section. A platinum wire, *m*, attached to a stretched membrane, M, completes the voltaic circuit by being immersed in water contained in the vessel W. The vibrations of the membrane modify the resistance of the transmitter, and consequently the intensity of the current. This is the principle of the battery telephone, and the Edison carbon telephone and the microphone are nothing but improvements upon this apparatus. Thus both Gray and Bell solved the problem, but by very different methods, for while Gray constructed his telephones with a battery and a liquid transmitter, Bell was the first to construct a magnetic telephone without any battery.

The number of telephones of different systems, like arc and incandescent lamps, increases every day, but all may be divided into two classes—telephones without batteries, or magnetic telephones, and telephones with batteries. This latter class includes carbon telephones and microphones. Every telephone, whatever its construction, consists of two parts—the transmitter, which transforms the vocal words into undulatory currents, which are sent along the line; and the receiver, which receives the undulatory currents, and transforms them again into sonorous vibrations. The first characteristic of magnetic telephones is the absolute identity of transmitter and receiver. A complete magnetic system therefore consists of two instruments only. The battery telephone employs four, two for each station. The simplest of all magnetic telephones is Bell's. The latest form given to this instrument by its inventor consists of a small wooden or ebonite box, A A (fig. 3, Plate XXIX.), which contains the magnet, *aa*, placed opposite the vibrating plate, *c*, and serves at the same time for holding the instrument in the hand. By means of a screw placed at the end of the handle, the magnet *a a* is brought near the vibrating plate or removed from it; and this is the only adjustment the instrument requires. At the end of the magnet is the coil *b*, the length of which and diameter of wire is proportionate to the length of the line to produce the best effects. The ends of the wire of the coil are attached to the terminals *e f*. The vibrating plate, which has only a diameter of 5 centimetres in its free part, and a thickness of $\frac{1}{30}$ to $\frac{2}{10}$ of a millimetre, is of sheet iron, and coated with varnish or tinfoil to prevent its oxidation. The mouth-piece, E, screws on to the box either by independent screws or by a channel screw, and the vibrating plate is squeezed between it and the box, and thus kept in position. On speaking before the mouthpiece of a telephone the plate vibrates; by its movements it modifies the division of magnetism in the magnetic bar, and gives rise to induced currents in the bobbin placed at its extremity.

The telephone is therefore a real generator of electricity of marvellous sensibility, which modulates the intensity of the currents it produces, and makes them follow all the varying and complicated undulations which characterize articulate sounds. These undulatory currents, thus developed in one telephone by the vibrations of the plate, are conveyed by two conducting wires to a second telephone, which transforms them conversely into sonorous vibrations. Here it may be assumed that the undulatory currents of alternately inverse directions reach the receiving telephone, and increase the magnetism of the bar if they traverse the bobbins in a direction favourable for magnetization, diminishing it if they are of the reverse nature; the plate obeys these changes of magnetization, approaches the coil when the magnetic force increases, withdraws from it by its own elasticity when the force diminishes, and by this undulatory action, like the exciting currents, vibrates in unison with the plate of the transmitting telephone, although with very much smaller displacements. Fig. 4 shows a more powerful form of the same instrument, intended for long circuits, in which the reference letters indicate the same parts. The sounds emitted by the receiving telephone are not perceptibly weakened by the interpolation of several telephones in the circuit. As many as ten or twelve telephones have been placed in the same circuit, and the words spoken at the other extremity of the line have been distinctly heard by ten or twelve persons at the same time. The successive transformations which take place in the inappreciable interval between the moment when the sound issues from the lips of the transmitter and the moment when it strikes the ear of the listener, are seven in number. (1) The vibration of the air sets the plate of the transmitter in motion; (2) this motion changes the magnetic division of the magnetic bar; (3) the change in the magnetic division develops induced currents in the bobbin of the transmitter; (4) these induced currents traverse the line and the bobbin of the receiver; (5) these currents produce changes in the magnetic bar of the receiver; (6) these changes of magnetism act on the plate and cause it to vibrate; (7) the vibrations of the plate are communicated to the air, and strike the tympanum of the listener's ear. This is one of the most beautiful illustrations of the equilibrium and the unity of natural forces; no change, however slight, can ensue in any one of them without immediately producing corresponding changes in all the others. The effort developed by the emission of a sonorous vibration is very slight, yet the telephone reproduces its echo at a distance of 250 to 300 miles. There have been numerous imitations of Bell's telephone, chiefly modifications without much practical value; one or two only will be noticed which have given in practice better results than the Bell telephone, enabling the listener to hear the words more distinctly on standing, in some cases, at a certain distance from the receiver. None of these modifications in any way constitute a new discovery or invention, but are simply an improvement of more or less practical value. The Gower telephone, or Gower-Bell apparatus, renders the words pronounced by the receiving instrument audible in every part of a room. In this apparatus (fig. 4, Plate XXVIII.) the magnet, N O S, is very powerful, although of small dimensions. The two poles carry oblong pieces of iron on which the bobbins are fixed. The whole is contained in a flat brass case, the cover of which carries the vibrating plate. The thickness of this plate is slightly greater than that of the Bell plate; it is fastened to the inside of the cover by a ring and screws, as shown at M.

In place of the ordinary mouthpiece a flexible acoustic tube is employed, with a mouthpiece at the end. The call signal consists of a small tube bent at right angles, with one end, T, opening near the vibrating plate, and the other end into the case. The tube contains an ordinary vibrating reed, L, shown half-scale. By blowing into the acoustic tube the reed vibrates and communicates its vibrations to the plate of the telephone. The intense vibrations set up produce powerful induced currents, which create at the distant receiver a considerable noise; the addition of this tube, A, on the vibrating plate in no way interferes with the clearness of transmission.

In magnetic telephones the transmitter acts as a generator of electricity; the mechanical work of the voice is partly transformed into induction currents, and these currents, on passing into the receiver, make it vibrate synchronously with the membrane of the transmitter. The currents sent along the line have therefore a limited intensity, and in no case can the receiving instrument emit more powerful sounds than those emitted or spoken before the transmitter. With battery telephones the case is different; the vibrations of the transmitter are no longer utilized to produce currents, but employed conveniently to distribute those emanating from a constant source; there intensity is therefore only limited by that of the source employed. Under such conditions the power of the receiver may be very great. All transmitters of battery telephones are founded on the same principle, that of utilizing the vibrations of a plate, or some such arrangement, in order to produce a variation of the electrical resistance of a circuit, and therefore to modify to a certain extent the intensity of the electric current traversing that circuit. This general principle requires therefore that the transmitter should be composed of a special material, with variable resistance arranged in the circuit, and modifying its resistance under the influence of the vibrations it receives. There are three classes of battery transmitters—namely, liquid transmitters, in which a liquid is employed to produce variable resistance; transmitters with voltaic arc, in which a thin layer of air and high-tension currents are employed; and carbon transmitters, which also comprise microphones. The first two forms have not given satisfactory results, and carbon transmitters are now exclusively used.

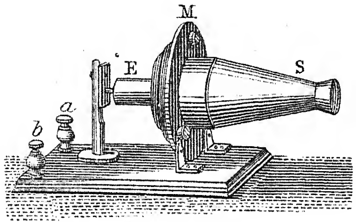
Edison invented and constructed the first carbon transmitter in 1876, immediately after Graham Bell's discovery. The first microphone is due to Hughes, in 1878; but the principle which Edison and Hughes first applied to the electrical transmission of sonorous vibrations was discovered by Count du Moncel in 1856. After numerous experiments on electrical interrupters, Du Moncel was the first to publish the fact that variation of pressure at the point of contact between two conductors touching each other had a considerable influence on the intensity of the resulting current. The variation of resistance at the point of contact is the greater the more resistance is offered by the conductors; it likewise depends upon their degree of hardness and upon the state of their surface. The original form of *Edison's carbon transmitter* has undergone numerous changes since its introduction in 1876. Figs. 5 and 6, Plate XXIX., show in elevation and section the form employed by Edison for telephonic communication. The apparatus consists of an ebonite mouthpiece, a vibrating plate, *c c*, and a disc of prepared carbon, *a*, of the size of a shilling piece. The carbon is placed on a support of vulcanite, *b*, which can be adjusted in its distance from the vibrating plate by the screw at the back part of the instrument. A little ivory button with a small platinum plate is fixed to the centre of the vibrating plate. The vibrations of the membrane are communicated to the carbon by the platinum plate; the variations of pressure thus produced cause a variation of electrical resistance in the carbon interposed between the circuit of a battery and a Bell's magnetic telephone receiver, and make it vibrate. In practice, the current of the battery, transformed by the speaker into an undulatory current, does not pass directly into the receiver, but traverses the inducing wire of a small induction coil, and leaves through the induced wire which is connected with the receiver of the opposite station. As in all battery telephones, the function of the transmitter is restricted to the production of variations of electrical resistance in the circuit; this variation immediately occasions a proportionate variation in an inverse sense in the intensity of the passing current. Thus for a given vibration, the change in the resistance of the circuit will have a certain value, which may be assumed to be represented by an ohm. If the whole circuit has a feeble resistance, as (say) 10 ohms, the variation of an ohm produced in the transmitter will vary the intensity by one-tenth of its total value, and consequently the receiver, which acts under the influence of these variations in intensity, will vibrate with considerable energy, and speak with a certain force. Should the total resistance of the circuit be large, say 1000 ohms, the variations of intensity will not be more than one-thousandth of the total intensity, the greater length of the line having largely reduced it. Edison has got over this difficulty by making the current of the transmitter pass into the thick wire of an induction coil, instead of directly traversing the line, as represented in diagram (fig. 5, Plate XXVIII). One end of the fine wire of the induced coils, s^1 and s^2, is connected with the earth, the other end is attached to the line, traverses the telephone of the receiving station, and passes to earth, or a double circuit may be employed, for reasons subsequently explained. The transmitter therefore only acts upon a feeble resistance, represented by the battery, the transmitter, and the inducing wire of the coils, P^1 and P^2, and the variations of the resistance of the transmitter have in consequence a considerable relative value. These variations manifest themselves in the inducing wire by variations of corresponding intensity, and in the induced wire by induction currents of proportional amplitude, and as the currents developed in the induced wire acquire in the coil a high tension, they are enabled to overcome large resistances, which allows of telephonic messages being sent a considerable distance with the current from a very small battery. In the Edison transmitter the carbon plate is the essence of the apparatus. It is made of lampblack obtained by burning petroleum lamps with long wicks in a nearly confined space. The lampblack after collection is compressed lightly under a coining press, forming a friable plate, but with sufficient cohesion to remain intact when kept in position between two thin platinum plates, and of extreme sensitiveness to variations of its electrical resistance in proportion to the pressure.

Blake's transmitter, which is largely used in England with induced currents in connection with Bell's telephone as a receiver, possesses considerable power. The contact which produces the variable resistance is formed by two movable pieces independent of the diaphragm, and always in slight contact with one another. The rigidity of one of the parts is replaced by its inertia by fixing the carbon to a heavy mass; the second part of the contact is formed by a small bead of platinum pressed slightly against the carbon by means of a small spring. The contact of the two pieces never being broken, no noise results in the instrument from the sudden opening or closing of the circuit.

The *microphone* is a telephone transmitter of great delicacy and of a special form. It takes its name from the power it possesses of amplifying mechanical vibrations of feeble intensity, which it transforms into undulating currents. These undulating currents, sent into a receiving telephone, frequently produce sonorous vibrations of much greater intensity than the original source. The simplest form of microphone, (fig. 6, Plate XXVIII.) consists of two nails, A A, fixed on a small horizontal board at a distance of about a millimetre apart. The wires, X Y, attached to these nails are connected with a battery, B, and a telephone; the space between the nails forms therefore the only interruption in the circuit. On placing a third nail across the two first the current passes through the points of contact of the nails, which form an imperfect contact, to which the apparatus owes its sensitiveness. This simple apparatus constitutes a perfect telephone transmitter, and words spoken and airs sung to this small nail, which will dance on the two others to the sounds or notes emitted, are instantaneously transmitted to the receiver at the other end of the circuit with marvellous clearness and power. A better effect is produced if gas carbon pencils are used instead of nails. The most sensitive microphone yet constructed, by Hughes, is equally simple. It consists of

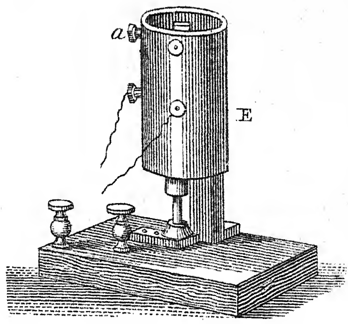
THE TELEPHONE.

Fig. 1.



Transmitter.

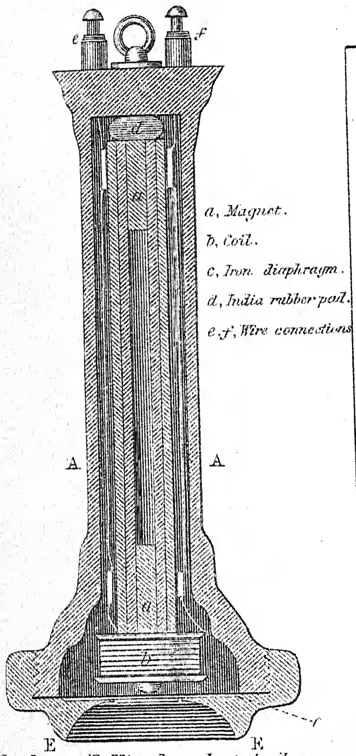
Fig. 2.



Receiver.

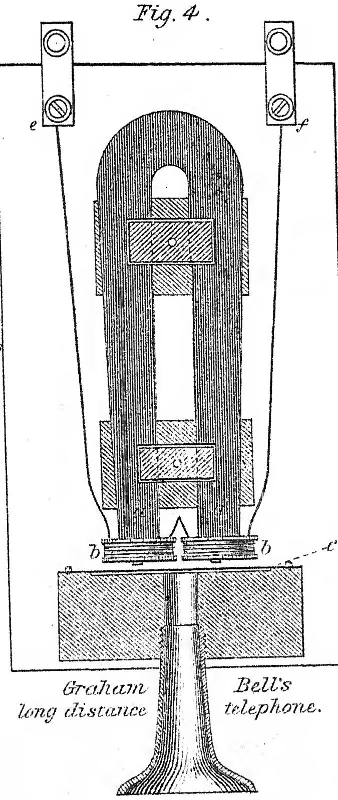
Instruments Exhibited at Philadelphia in 1876.

Fig. 3.



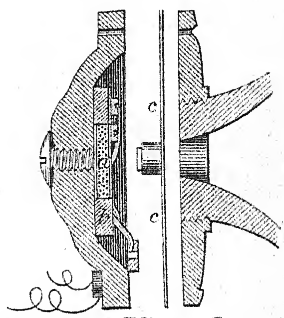
Graham Bell's hand telephone.

Fig. 4.



Graham Bell's long distance telephone.

Fig. 5.



Section of Edison's Transmitter.

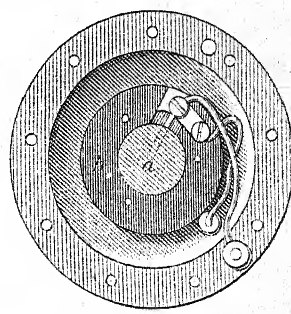


Fig. 6.

Edison's Transmitter.
a, Carbon. b, Vulcanite ring. c, diaphragm.

Fig. 7.

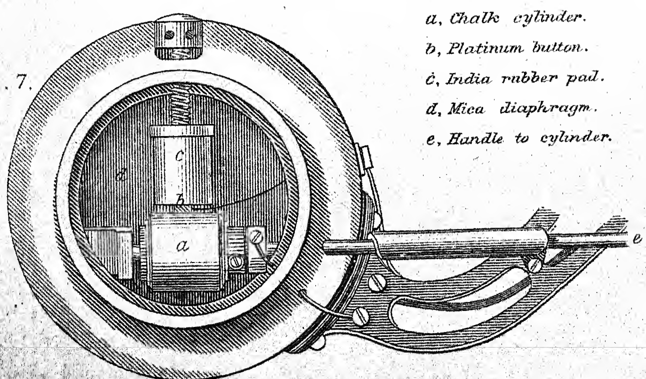
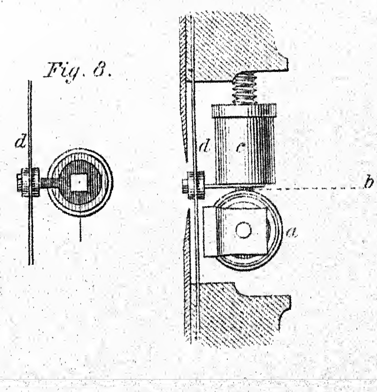


Fig. 8.



Receiver of Edison's Electro-chemical Loud speaking Telephone.

a small pencil of gas carbon, A, fig. 7, terminating in a point at each end, the two ends resting lightly between two pieces of carbon, O O′, which are hollowed out with two small circular holes to receive the points. The carbon pencil has a vertical position, and the carbon pieces are attached to a thin wooden sounding-board, placed on a solid block D. The wires X Y, attached to the battery, and the line wire leading to the telephone, are connected to O O′. This instrument is of such marvellous delicacy that the tread of a fly or other insect walking on the board D is distinctly heard at a distance of more than a mile from the transmitter.

Ader's microphonic transmitter, largely employed in France, consists of ten small carbon pencils arranged in two rows of five each, their ends resting on three cross-bars of carbon fixed to a small deal board, which receives the vibrations, and at the same time forms a cover to the apparatus. This lid is fastened to a leaden base, supported on four india-rubber feet, in order to prevent the concussions of a stage floor or other movements from reaching the transmitter. The inertia of the lead block and elasticity of the rubber feet enable this apparatus to be used at the opera, even where the floor is violently shaken by the dancing. The transmitter is therefore only influenced by the sonorous air-waves.

Edison's electro-chemical telephone is constructed on the following principle:—When a sheet of blotting paper is saturated with a solution of caustic potash and placed on a metal plate in connection with the + pole of a battery, on passing a platinum strip about 1 centimetre wide over the surface of the paper with a certain amount of pressure a resistance to the sliding motion is felt, arising from the friction of the platinum foil against the paper. If the platinum strip while sliding over the surface of the paper is connected with the − pole of the battery, the resistance to the sliding will be greatly diminished; that is, the electric current diminishes the coefficient of friction between the platinum foil and the surface of the paper. This effect of the electric current is proportionate to the intensity of the current; it commences and finishes with it, and is so sensitive that the feeblest currents are rendered perceptible. Edison's receiver, shown in elevation and section (figs. 7 and 8, Plate XXIX.), is constructed on this principle. It consists of a thin plate of mica, *d*, 8 or 9 centimetres in diameter, which carries in its centre a platinum plate, *b*, pressing against the surface of the cylinder *a* with a constant pressure due to the india-rubber pad, *c*, or a spring, and regulated by a screw. The cylinder *a* is composed of a paste made up of lime, caustic potash, and a small quantity of acetate of mercury. This paste is the equivalent of the blotting paper soaked in potash previously referred to. The cylinder *a* revolves with a regular motion by means of the shaft *e* in connection with a clockwork movement. The current, arriving from the transmitter at the distant station, traverses the cylinder *a* and the platinum plate *b*, and leaves by the wire attached to the platinum plate. On turning the cylinder *a* the friction produces a strain on the platinum plate, which is transferred to the mica disc *d*, which will thus vibrate synchronally with the undulating current, and consequently synchronally with the membrane of the transmitter. This vibratory motion of the mica disc is not therefore directly obtained by the electric current, but is produced mechanically by the rotation of the cylinder *a*. The current only produces a certain variation of resistance to the sliding motion, and hence the great power of the apparatus.

PHOTOPHONE.

Graham Bell and Sumner Tainter have constructed a telephone by which speech has been transmitted to a distance by means of a luminous ray. This apparatus, which is termed a *photophone*, depends upon the extreme sensitiveness of selenium to the influence of light, and the circumstance that this influence manifests itself by variations of the electrical resistance of selenium. The photophone is constructed as follows:—The rays of a powerful and constant luminous source, such as the sun, are thrown on a thin and highly polished metallic mirror. On speaking behind this mirror its curve is modified in such a manner that the reflected rays are dispersed according to the vibrations of the plate, and vary in intensity in a given direction. At the receiving station the luminous rays of variable intensity strike a parabolic mirror, which concentrates them in its focus; a cylinder of selenium, specially prepared for the purpose, is placed in the focus of the mirror. This selenium modifies its electrical resistance according to the intensity of the rays which strike it, and as it is placed in the circuit of a battery, and of a Bell's telephone, it acts after the manner of a microphone in changing the intensity of the current in the circuit, and produces articulate sounds in the telephone. This result is simply marvellous. Articulate speech can be produced by the lime-light, and even by that of a paraffin lamp.

The practical applications of the telephone are very numerous; the system of telephonic exchanges which has been introduced in large cities and towns daily increases the importance and usefulness of the invention. The power and sensitiveness of telephonic communication are forcibly illustrated by the repetition of theatrical performances. Not only the voices of the actors and actresses, the songs, and the orchestra are distinctly heard, but all the incidents of the performance, the applause and laughter of the audience, and in some instances the voice of the prompter. Telephonic communication has been successfully made between New York and Chicago, a distance of 1000 miles. This result is not, however, solely due to the telephone, but mainly to the employment of a conductor composed of a steel wire copper-plated, the electrical resistance of which between New York and Chicago was only 1522 ohms, as against upwards of 15,000 ohms, the average resistance of the ordinary telegraph circuit.

The telephone has been successfully used in diving operations; at the depth of 56 feet its distinctness was not materially affected. When using the telephone for submarine purposes a small hole must be made in the plate of the instrument, otherwise this latter will be warped and stick against the magnet through excess of pressure.

The extreme sensitiveness of Bell's telephone to the feeblest currents has suggested its employment to detect currents too feeble to affect the most sensitive galvanometer. The currents must, however, be intermittent, or they will not maintain the disc of the telephone in vibration. This property has been applied by Hughes to the construction of an instrument termed the *induction balance*.

A small battery B, fig. 5, Plate XXVIII., is connected with a microphone M, by means of two coils of wire P^1 P^2, wound on bobbins fixed on a suitable stand. In connection with each of these primary bobbins are two secondary coils, S^1 and S^2, of wire of the same size, and exactly of the same length, but wound in opposite directions. These secondary coils are connected with a telephone T, and the result of this arrangement is that whenever a current begins or ceases to flow in the primary coils, the coil P^1 induces a current in S^1, and P^2 in S^2. The two currents thus induced in the secondary wire neutralize one another, and if they are of equal strength balance one another so exactly that no sound is heard in the telephone. As a perfect balance cannot be obtained unless the resistances and the co-efficients of mutual induction and of self-induction are alike, if a small piece of metal be introduced between S^1 and P^1 there will be less induction in S^1 than in S^2, as a part of the inductive action in P^1 will be spent in setting up currents in the mass of the metal, and a sound will be heard in the telephone. Balance may, however, be restored by moving S^2 further away from P^2 until the induction in S^2 is made equal to S^1, when the sounds in the telephone cease. By this means the relative conductivity of different metals introduced into the coils may be ascertained, and counterfeit coins can be detected by the indications thus afforded of their conductivity. The induction balance has also been applied in surgery to detect the presence of a bullet in a wound, for a lump of metal will disturb the induction even when some inches distant from the coils.

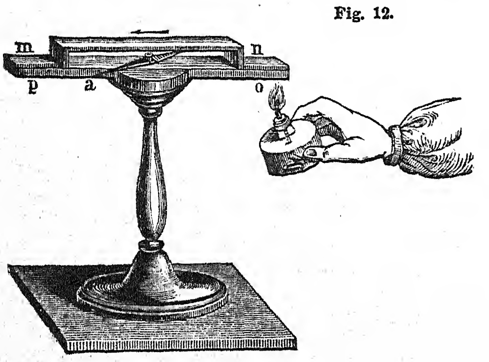
When networks of telephone wires are established, the forced close proximity of the wires develops a very serious difficulty, as the reciprocal induction of the different wires produces a very Babel of conversations, while induction from telegraph wires, the wires of electrical tramways, or those used in connection with electric lighting, cause a distressing com-

plication of sounds which make the telephone message inaudible. The only method hitherto found successful in overcoming these difficulties has been the use of a complete metallic circuit, consisting of two parallel wires, instead of employing the earth as the return circuit. It is evident that the effect of electrical disturbance by induction on these two wires (if sufficiently close together) will be equal, and as they are carrying currents in opposite directions such effects will neutralize each other, and produce no sound in the receiver. This system is consequently being generally introduced in large cities, and is used on all long-distance circuits such as now connect all the greater cities of the United Kingdom. Special submarine cables connect London telephonically with Paris and the Continent, and a similar cable connects Great Britain with Ireland. For many business purposes the telephone promises to take the place of the telegraph.

THERMO-ELECTRICITY.

The highly important fact that a current of electricity may be produced in a closed circuit by heating a point of contact of two dissimilar metals was discovered in 1821 by Professor Seebeck of Berlin. Thus if a plate of copper, *m n* (fig. 12), is bent into the form shown, and its ends soldered to a plate of bismuth, *o p;* and if a magnetic needle, *a*, is pivoted in

Fig. 12.



the centre of the circuit, when the apparatus is placed in the magnetic meridian, and one of the solderings is gently heated, the needle will be deflected in a manner which indicates the passage of a current from *n* to *m*—that is, from the heated to the cool junction in the copper. If one junction is cooled below the temperature of the rest of the circuit, a current in the opposite direction is generated. The electro-motive force thus set up will maintain a constant current so long as the excess of temperature of the heated junction over the other is maintained, heat being all the time absorbed in order to maintain the energy of the current. The currents thus generated are known as thermo-electric.

Peltier, in 1834, discovered a phenomenon the converse of that discovered by Seebeck—namely, that if a current of electricity is passed through a junction of dissimilar metals, the junction is either heated or cooled, according to the direction of the current. A current passing through a bismuth and antimony pair in the direction from the bismuth to the antimony absorbs heat in passing the junction of these metals, and cools it; but if the current flows from the antimony to the bismuth it evolves heat, and the temperature of the union is raised. This phenomenon is known as the "Peltier effect," to distinguish it from the ordinary heating of a circuit where it offers a resistance to the current, and from which it is distinctly different, as in the Peltier effect the current heats or cools the junction according to the direction in which it flows, and the amount of heat evolved is proportional simply to the strength of the current; whereas a current meeting with resistance in a thin wire evolves heat in whichever direction it flows through the wire, and the amount of heat is as the *square* of the strength of the current. In determining the heat developed in a circuit, therefore, it is necessary to take into consideration any Peltier effects which may exist at metal junctions in the circuit. If the letter P represents the difference of potential due to the heating of the junction, expressed as a fraction of a volt, the law of heat becomes

$$H = 0{\cdot}24 \times (c^2Rt + Pct).$$

The quantity P is termed the coefficient of the Peltier effect. It has different values for different pairs of metals, and is numerically equal to the number of *ergs* of work which are the dynamical equivalent of the heat evolved at a junction of the particular metals by the passage of one *ampere* of electricity through the junction. The annexed list, taken from Matthiessen's tables, gives the comparative numerical values of the electro-motive force of different pairs of metals—

Bismuth, . .	+25	Gas coke, . .	− 0·1
Cobalt, . . .	" 9	Zinc, ...	" 0·2
Potassium, . .	" 9·5	Cadmium, . .	" 0·3
Nickel, . . .	" 5	Strontium, . .	" 2·0
Sodium, . . .	" 3	Arsenic, . . .	" 3·8
Lead, ...	" 1·03	Iron, ...	" 5·2
Tin, ...	" 1	Red phosphorus,	" 9·6
Copper, . . .	" 1	Antimony, . .	" 9·8
Silver, . . .	" 1·0	Tellurium, . .	− 179·9
Platinum, . .	" 0·7	Selenium, . .	" 290·0

In this list, taking the electro-motive force of the copper-silver couple as unity, the electro-motive force of any pair of metals is expressed by the difference of the numbers where the signs are the same, and by the sum where the signs are different. Thus the electro-motive force of a bismuth-nickel couple is 20, of a cobalt-iron couple 14·2, and of an iron-antimony couple − 4·6. Whatever may be the metals entering into the composition of the thermo-electric couples they are readily distinguished from hydro-electric couples by the nature of the currents. In a voltaic battery each couple or element possesses a strong tension of from one to two volts, and an interior resistance of from 0·2 to 15 or 20 ohms. In the thermo-electric couple, for a difference of temperature of 100° C. between the solderings, the electro-motive force, varying with the nature of the constituting elements and the mean temperature of the two solderings, ranges between $\frac{1}{20}$ and $\frac{1}{300}$ volt, whilst the interior resistance is very small. Thermo-electric batteries therefore give quantity and but little tension, and a large number of them must be connected in series to obtain a certain electro-motive force. It would seem natural that by selecting the most remote elements of the series for the formation of a couple the greatest electro-motive force would be obtained for a given temperature. Considerations of a theoretical and practical nature show that such is not the case. In practice those metals or alloys are selected in which the difference of temperature of the solderings can be maintained at the highest possible degree without altering the battery.

The law stating that the electro-motive force of thermo-electric currents is proportional to the difference of temperature, is only correct with special reservations as to the mean temperature of the two solderings, and to the neutral point, which varies with the nature of the metals employed. This neutral point will be understood by taking a thermo-electric couple of copper and iron. Let the cold soldering be at 21° C., and the hot soldering at 232° C. No current will pass through the couple thus constituted, although the difference of temperature is 211° C. The reason is that the neutral point of iron with regard to copper is 99° C.—that is, at 99° C. the thermo-electric current formed by the two metals changes its direction; and as the mean temperature between the two solderings is the same, two currents of equal tension, but different directions, are produced, which neutralize each other. Care must therefore be taken, while maintaining a great difference of temperature between the two solderings of a thermo-electric couple, that the one is not higher, and the other lower, than the neutral point of the two metals forming the couple, as then only a differential current would be obtained, liable to neutralization when the mean temperature of the two solderings corresponds to the neutral point.

If the difference of temperature is maintained constant the current is constant, as there is no polarization or variation produced in the resistance of the couple; and the electro-motive force of a thermo-electric battery is proportional to the number of elements forming the battery, exactly as is the case with voltaic batteries.

Nobili has devised a thermo-electric pile, in which a large

number of elements are contained in a very limited space. Couples of bismuth and antimony are joined up in such a manner that in a series of five couples, as shown in fig. 13, the last bismuth of one series is soldered to the antimony of a second series; the last bismuth of this series to the antimony of a third, and so on for the four vertical series, containing together twenty couples, commencing with antimony and finishing with bismuth. The couples thus arranged are insulated from one another by means of small paper bands varnished, and the whole inclosed in a copper frame, P, so that only the solderings are exposed at the two ends of the pile. Two metal binding screws, X Y, insulated in an ivory ring, communicate in the interior, one with the first antimony representing the + pole, and the other with the last bismuth representing the − pole. As a means of detecting excessively small differences of temperature the thermopile is an invaluable instrument, the currents being proportioned to the difference of temperature between the hotter set of solderings on one face of the thermopile and the cooler set on the other face. By its means a difference of temperature, no greater than the $\frac{1}{2200}$ part of a degree, may be measured, and the heat of the fixed stars has been made sensible. The arrangement of the thermopile and galvanometer for such delicate measurements is shown in fig. 14. The pile is contained in

Fig. 13.

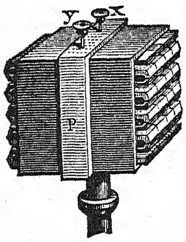
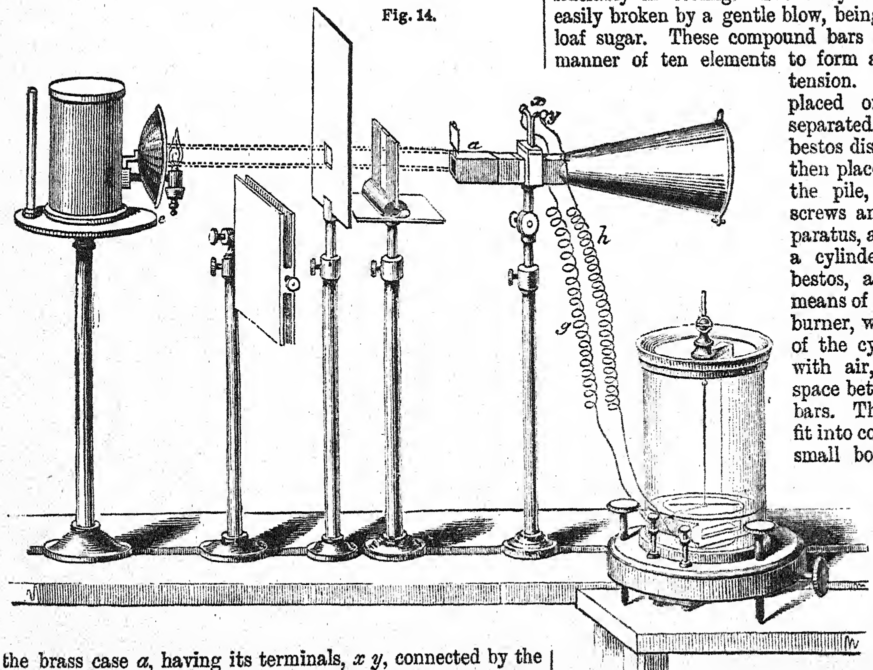


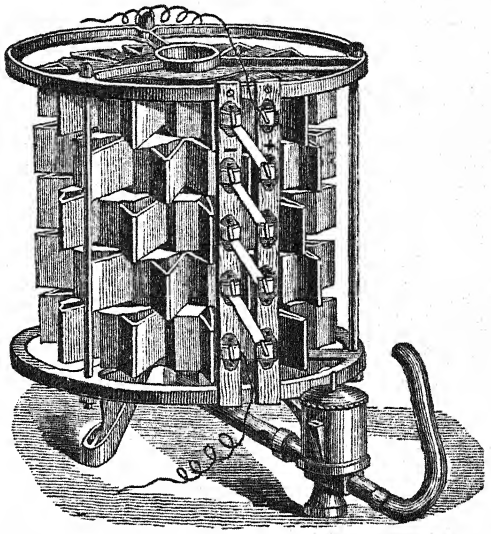
Fig. 14.



the brass case a, having its terminals, x y, connected by the wires g h with a delicate galvanometer, c. When one extremity of the pile is exposed to radiation from any source of heat, as the lamp, e, a deflection of the galvanometer needle is observed. Screws of various materials may be arranged for testing, as shown in the figure.

The most practical thermo-electric battery yet introduced is that of M. Clamond of Paris, which has proved very successful for telegraphic purposes. The mixture employed by M. Clamond consists of an alloy of two parts of antimony and one of zinc for the − metal, and for the + element he employs ordinary tinned sheet-iron, the current flowing through the hot junction from the iron to the alloy. The combination is one of considerable power. Each element consists of a flat bar of the alloy about 2 inches long and about an inch in thickness, rather broader in the middle than at the ends, the average middle breadth being five-eighths of an inch. Strips of the sheet-iron of suitable form are placed in the mould, and the melted alloy poured in; the mould is heated nearly to the melting point of the alloy, which is about 260° C.; it expands considerably in cooling. The alloy is extremely brittle, and easily broken by a gentle blow, being scarcely stronger than loaf sugar. These compound bars are arranged in a radial manner of ten elements to form a star, and coupled for tension. Several of these stars are placed one above another, and separated from each other by asbestos discs. Cast-iron frames are then placed at top and bottom of the pile, and kept in place by screws and rods. The whole apparatus, as shown in fig. 15, forms a cylinder, lined inside with asbestos, and heated with gas by means of a perforated earthenware burner, which occupies the centre of the cylinder. The gas, mixed with air, burns in the annular space between the burner and the bars. The terminals of these bars fit into copper clamps, fixed on two small boards, and this arrangement allows the coupling together of the series either for tension or for quantity. The tension produced by Clamond's thermo elements is such that each twenty elements may be taken as practically equal to one Daniell cell, or one volt. The thermopiles are so sensitive that the passing of the hand into the interior, the breathing into them, or the approach of a body, immediately sets up a considerable action, and while they are in action the effect of a distant fire, or the opening of a window, produces a sensible effect on their potential. It is therefore necessary, when two or more piles are employed, to keep them as far apart as possible, and to allow them free radiation. Little progress has, however, been made in the practical application of thermo-electricity, and at present thermo-electric apparatus present chiefly a scientific interest.

Fig. 15.

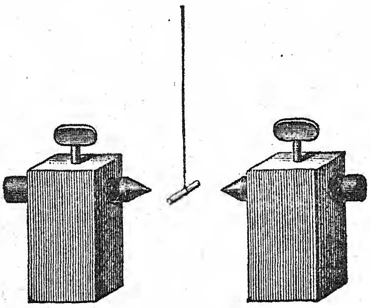


DIAMAGNETISM.

The repellant action of the magnet upon certain substances was first noticed in 1778 by Brugmans of Leyden, who observed that a lump of bismuth when suspended near either

pole of a magnetic needle repelled it. Coulomb, in 1802, likewise observed that magnets acted upon all bodies in a greater or less degree. In 1827 Le Baillif and Becquerel noticed that antimony also would repel and be repelled by the pole of a magnet. It was not, however, until 1845 that Faraday, by means of very powerful electro-magnets, determined the magnetic properties of a large number of substances, and made the important discovery that all solid and liquid bodies so far examined are either attracted or repelled by a powerful electro-magnet. These two classes of bodies are termed *magnetic* and *diamagnetic*, and the property of being thus repelled from a magnet is termed *diamagnetism*. The method of experiment adopted by Faraday consisted in suspending a small bar of the substance to be examined

Fig. 16.



between the poles of a powerful magnet, and observing whether the small bar was attracted into an axial position —that is, with its length in a line joining the two poles—or whether it was repelled into an equatorial position, at right angles to the line joining the two poles across the lines of force of the magnetic field, as in fig. 16. Some of the principal substances examined are as follows:—

Magnetic.		Diamagnetic.	
Iron.	Titanium.	Bismuth.	Gold.
Nickel.	Platinum.	Phosphorus.	Water.
Cobalt.	Oxygen gas.	Antimony.	Alcohol.
Manganese.	Ores and salts	Zinc.	Selenium.
Chromium.	containing	Mercury.	Sulphur.
Cerium.	the above	Lead.	Thallium.
	metals.	Silver.	Hydrogen gas.
		Copper.	Air.

Chemically pure platinum, according to the experiments of Weidermann, is diamagnetic. When a small cube of copper is suspended by a fine silk thread between the poles of the electro-magnet, and set spinning in rapid rotation, the moment the current passes through the coils of the electro-magnet the rotary motion is arrested. In experimenting with liquids very thin glass tubes filled with the fluid are suspended between the poles of the magnet. If the liquids are magnetic, such as solutions of iron, cobalt, and solutions of salts of the magnetic metals, the tubes set axially; but almost all liquids are diamagnetic. Thus with water, milk, blood, alcohol, ether, oil of turpentine, and most saline solutions, the tubes set equatorially. According to its composition glass is sometimes magnetic and sometimes diamagnetic. In all experiments with glass tubes it is therefore needful first to determine its character, and make the necessary allowance in the experiments. In examining gases bubbles are blown with the gas under examination, and according as they are drawn into or pushed out of the magnetic field their condition is determined. Oxygen gas is found to be strongly magnetic, and ozone to be still more so.

The magnetic or diamagnetic power of a body is expressed in terms of a certain coefficient of magnetization, k, which is the ratio of the intensity of magnetization to the magnetizing force of the field in which the substance is placed. If the intensity of magnetization be represented by i, and the strength of the magnetizing field by H, then $i = k\,\mathrm{H}$. For magnetic bodies k has + values; for diamagnetic substances k has − values. The value of k for iron is variously given as + 45 and + 32·8; the value of k for soft iron in thin wires magnetized within a solenoid is from 1300 to 1400. For bismuth the value of k is −0·0000025, as given by Clerke-Maxwell. The magnetic powers of equal weights of substances have been compared by Plücker, and taking that of iron as represented by 1,000,000 the following values for the *specific magnetism* of substances have been determined:—

Iron, . . .	+ 1,000,000	Iron oxide, . .	+ 759
Cobalt, . .	1,009,000	Nickel oxide, .	287
Nickel, . .	465,800	Water, ...	− 25
Lodestone, .	402,270	Bismuth, . . .	− 23·6
		Phosphorus, . .	− 13·1

ARITHMETIC.—CHAPTER XV.

COMMERCIAL CALCULATION—PRACTICE.

In the early days of commerce there was not much need for intricate computations, and even when trade grew more diffused, though absolute accuracy was required, speed was not regarded as essential. As business became more intense, and the division of labour, in conducting it, was found to be increasingly possible, traders got familiarized with simple methods of calculation in particular branches, and in the use of these gained great expedition and facility by practice. Hence any arithmetical operation rendered easy by ready familiarity with the facts of special figures, dexterity in their use, and retentiveness of memory as regarded processes and results was colloquially said to be "done by practice." For example, many articles are sold by dozens, scores, hundreds, &c.; in such cases we can abbreviate operations, thus:—

(1) To find the price of a dozen articles, (*a*) call the pence which one costs shillings—*e.g.* 12 @ 1*s.* 7*d.* = 19*s.*; (*b*) count $\frac{1}{4}$ 3*d.*, $\frac{1}{2}$ 6*d.*, $\frac{3}{4}$, 9*d.* and other fractions proportionately—*e.g.* 12 @ 1$\frac{1}{4}$*d.* = 1*s.* 3*d.*; 12 @ 1*s.* 3$\frac{1}{2}$*d.* = 15*s.* 6*d.*; 12 @ 2*s.* 1$\frac{3}{4}$*d.* = £1 5*s.* 9*d.*; 12 @ 3$\frac{1}{8}$*d.* = 3*s.* 1$\frac{1}{2}$*d.*, &c.

(2) To find the price of a score (20), call the shillings which one costs a *pound*, and reckon each 6*d.* as 10*s.*, 3*d.* as 5*s.*, and 9*d.* as 15*s.* and so on—*e.g.* 20 @ £1 7*s.* = £27; 20 @ 18*s.* 6*d.* = £18 10*s.*; 20 @ 3*s.* 9*d.* = £3 15*s.*, &c. To reverse the process, given the price of a dozen in shillings call each shilling a penny and the price of one is gained; if a score call each pound a shilling. Deal with fractional parts as before.

(3) To find the price of 100 articles. For each farthing in the price, take as many pence and twice as many shillings. Two shillings for each farthing is equal to multiplying by 96, and a penny for each farthing is like multiplying by 4, so that 96 + 4 = 100, *e.g.* 100 @ 4$\frac{1}{2}$*d.* = £1 17*s.* 6*d.*; 100 @ 5$\frac{3}{4}$*d.* = 46*s.* + 1*s.* 11*d.* = £2 7*s.* 11*d.*; 100 @ 1*s.* 2$\frac{1}{2}$*d.* = £6 0*s.* 10*d.*

(4) To find the price of a gross (144), count the pence in the price of one shillings, and the pence in these shillings reckoned as shillings will be the price of a gross in shillings, *e.g.* 144 @ 1*s.* 4$\frac{1}{2}$*d.* = £9 18*s.*; 144 @ 11$\frac{3}{4}$*d.* = £7 1*s.*

(5) Given the price of a hundredweight (112 lbs.) in shillings, to find the price per ton:—Call the shillings in the price of one a pound—*e.g.* 1 ton @ 3*s.* per cwt. = £3; 12 tons @ 6*s.* per cwt. = £72; 7 tons @ 37*s.* 6*d.* per cwt. = £262 10*s.*

(6) By regarding tons as pounds, cwts. as shillings, quarters as 3*d.*, a ready answer is got in pounds or aliquot parts of a pound—*e.g.* 12 tons 16 cwts. 3 qrs. @ £1 = £12 16*s.* 9*d.*; @ £2 = £25 13*s.* 6*d.*; @ £8 = £102 14*s.*

(7) Given the price of one lb., to find that of a ton. Multiply the farthings contained in the price of a lb. by 7 and divide by 3, and the price of a ton in £. *s.* *d.* will be found; *e.g.* 1 lb. costs 4$\frac{1}{4}$*d.* 17 × 7 = 119 ÷ 3 = £39 13*s.* 4*d.* Conversely, multiplying the price of a ton by 3 and dividing by 7 gives the price of a lb. in farthings; *e.g.* 1 ton costs £84, what is the price per lb.? 84 × 3 = 252 ÷ 7 = 36 farthings = 9*d.* per lb.

(8) The price of one lb. being given, to find that of a qr. Multiply 2*s.* 4*d.* by the price; *e.g.* 1 qr. @ 9*d.* = £1 1*s.*

(9) Given the price of an ounce avoirdupois, to find the value of one lb. Divide the farthings in the price of an ounce by 3, the answer will be the price in shillings—*e.g.* 1 lb. avoir. @ 10$\frac{1}{4}$*d* = 41 far. ÷ 3 = 13*s.* 8*d.*; in a lb. troy, reckon each penny a shilling—1 lb. troy @ 11$\frac{1}{2}$*d.* = 11*s.* 6*d.*; 7 lbs. at 10$\frac{1}{4}$*d.* = £3 11*s.* 9*d.* Conversely, if the price of a lb. troy is given we find the value of an ounce by reckoning each shilling a penny—*e.g.* 1 oz. at 9*s.* per lb. = 9*d.*; and of a lb. avoirdu-

pois, by reckoning each shilling a farthing and multiplying by 3—*e.g.* 1 oz. avoir. @ 6*s.* per lb. = 18 far. = $4\frac{1}{2}$*d.*

(10) The price per lb. being given, to find that of a stone, reckon the pence shillings and add $\frac{1}{6}$—*e.g.* 1 lb. @ 3*s.* 8*d.*, what is the cost of a stone? 3*s.* 8*d.* = 44 + $\frac{1}{6}$ = £2 11*s.* 4*d.*

(11) In the case of articles sold in quantities of 240, as a *load* of meal, flour, potatoes, &c., a *pack* of wool, by reckoning each penny as a pound we get the total; in quantities of 60 each penny is reckoned as 5*s.*, of 120 each penny as 10*s.* and so on—*e.g.* one load of flour @ $\frac{3}{4}$*d.* per lb. = 15*s.*; a fagot (120 lbs.) of steel at $3\frac{1}{2}$*d.* per lb. = £1 15*s.*

(12) By annexing a cipher to the total money price of any article in shillings, and dividing by half the price of one article, we can readily discover how many hundredweights, pounds, yards, &c., of these can be bought for the sum—*e.g.* for £63, how many articles can I buy at £1 1*s.*? *Ans.* 60.

The constant relation between quantity and price supplies the means of easily resolving many questions in commercial arithmetic by the substitution of similars. Another form of Practice aids the reckoner in computations less frequently recurrent than the foregoing.

Practice is a simple method of finding the value of quantities by the use of aliquot parts of the price given. An aliquot part of a unit is any fraction of it which is found an exact number of times. Of 20*s.* for example 1*d.* = $\frac{1}{240}$, $1\frac{1}{2}$*d.* $\frac{1}{160}$, 2*d.* = $\frac{1}{120}$, 4*d.* = $\frac{1}{60}$, 5*d.* = $\frac{1}{48}$ 6*d.* = $\frac{1}{40}$, 8*d.* = $\frac{1}{30}$, 1*s.* = $\frac{1}{20}$, 1*s.* 3*d.* = $\frac{1}{16}$, 1*s.* 8*d.* = $\frac{1}{12}$, 2*s.* = $\frac{1}{10}$, 2*s.* 6*d.* = $\frac{1}{8}$, 3*s.* 4*d.* = $\frac{1}{6}$, 4*s.* = $\frac{1}{5}$, 5*s.* = $\frac{1}{4}$, 6*s.* 8*d.* = $\frac{1}{3}$, 10*s.* = $\frac{1}{2}$. At each of these prices the answers are found on dividing by the denominator of the aliquot part, *e.g.* 324 @ 1*d.* = £1 7*s.*; 324 @ $1\frac{1}{2}$*d.* = £2 0*s.* 6*d.*; 324 @ 2*d.* = £2 14*s.*; 324 @ 4*d.* = £5 8*s.*; 324 @ 5*d.* = £6 15*s.*; 324 @ 6*d.* = £8 2*s.*; 324 @ 8*d.* = £10 16*s.*; 324 @ 1*s.* = £16 4*s.*; 324 @ 1*s.* 3*d.* = £20 5*s.*; 324 @ 1*s.* 8*d.* = £27; 324 @ 2*s.* = £32 8*s.*; 324 @ 2*s.* 6*d.* = £40 10*s.*; 324 @ 3*s.* 4*d.* = £54; 324 @ 4*s.* = £64 16*s.*; 324 @ 5*s.* = £81; 324 @ 6*s.* 8*d.* = £108; 324 @ 10*s.* = £162.

By the exercise of a little ingenuity almost any intermediate fractional sum may be laid down in aliquot parts, those having the simplest denominators being always preferred. Attention being paid to the derivation of the aliquot parts, Practice supplies an easy means of working sums at very complex prices—*e.g.*

(1)	126 @ £1 7 2
5*s.* = $\frac{1}{4}$	31 10 0
1*s.* 8*d.* = $\frac{1}{3}$	10 10 0
5*d.* = $\frac{1}{4}$	2 12 6
1*d.* = $\frac{1}{5}$	0 10 6
	£171 3 0

(2)	205 @ £1 3 $7\frac{3}{4}$
2*s.* 6*d.* = $\frac{1}{8}$	25 12 6
10*d.* = $\frac{1}{3}$	8 10 10
$2\frac{1}{2}$*d.* = $\frac{1}{4}$	2 2 $8\frac{1}{2}$
$1\frac{1}{4}$*d.* = $\frac{1}{2}$	1 1 $4\frac{1}{4}$
	£242 7 $4\frac{3}{4}$

(3)	373 @ £4 16 $10\frac{1}{2}$
	4
	1492
10*s.* = $\frac{1}{2}$	186 10 0
5*s.* = $\frac{1}{2}$	93 5 0
1*s.* 8*d.* = $\frac{1}{3}$	31 1 8
$2\frac{1}{2}$*d.* = $\frac{1}{8}$	3 17 $8\frac{1}{2}$
	£1806 14 $4\frac{1}{2}$

(4)	198 @ £8 18 $10\frac{1}{4}$
	8
	1584
10*s.* = $\frac{1}{2}$	99 0 0
5*s.* = $\frac{1}{2}$	49 10 0
2*s.* 6*d.* = $\frac{1}{2}$	24 15 0
1*s.* 3*d.* = $\frac{1}{2}$	12 7 6
$1\frac{1}{4}$*d.* = $\frac{1}{12}$	1 0 $7\frac{1}{2}$
	£1770 13 $1\frac{1}{2}$

The method of aliquot parts may be employed when either the goods or the price, or both, are given in several denominations; *e.g.*

What—fractions of farthings being disregarded—will be the cost of 5 cwts. 3 qrs. 18 lbs. @ £3 17 8 per cwt.?

(1)	5 cwts. 3 qrs. 18 lbs. @ £3 17 8
	5
	19 8 4
2 qrs. = $\frac{1}{2}$	1 18 10
1 qr. = $\frac{1}{2}$	0 19 5
14 lbs. = $\frac{1}{2}$	0 9 $8\frac{1}{2}$
$3\frac{1}{2}$ lbs. = $\frac{1}{4}$	0 2 5+
$\frac{1}{2}$ lb. = $\frac{1}{7}$	0 0 4+
	£22 19 $0\frac{1}{2}$

(2)	£3 17 8
	6
	23 6 0
8 lbs. = $\frac{1}{14}$	5 $6\frac{3}{4}$
2 lbs. = $\frac{1}{4}$	1 $4\frac{3}{4}$
	6 $11\frac{1}{2}$
	£22 19 $0\frac{1}{2}$

(3)		
5 cwts. 0 qrs. 0 lbs. @ 3 17 8	=	£19 8 4
2 0 = $\frac{1}{2}$	=	1 18 10
1 0 = $\frac{1}{2}$	=	0 19 5
14 = $\frac{1}{2}$	=	0 9 $8\frac{1}{2}$
$3\frac{1}{2}$ = $\frac{1}{4}$	=	0 2 5+
$\frac{1}{2}$ = $\frac{1}{7}$	=	0 0 4+
		£22 19 $0\frac{1}{2}$

For decomposing the compound multiplier into convenient parts of the highest denomination, and these again into inferior parts till their aggregate, the whole compound multiplier, has been arranged in aliquot parts, no general rule can be given. Almost every branch of business has its own special forms of computation intended to secure speed and ease. When the principles of arithmetic are understood, all these are found to be simple practical expedients, founded on the facts explicitly demonstrated in the theory of numbers. It is of the highest consequence that the principles of numerical computation should be distinctly understood, as these really govern all the dexterous forms of practical calculation.

It has been found advisable to treat of involution, evolution, and square and cube root in algebra, Chap. XIII. pp. 1301–1304, to which pages we, in closing these lessons, desire to direct the student's attention.

BOOK-KEEPING.—CHAPTER XV.

ON BALANCING BOOKS, AND THE RULES TO BE OBSERVED IN DOING SO.

The theory of book-keeping, though simple in itself, often, in its application to extensive and complicated transactions, requires the exercise of high talent, and in every circumstance demands a clear head and a steady mind. "To know the good order of keeping the famous reckoning called in Latin *Dare* and *Habere*, and in English *Debitor* and *Creditor*," is far more important now than when, in 1543, Hugh Oldcastle, schoolmaster, issued in London the earliest known work on book-keeping in the English tongue. Real business has now grown to dimensions then undreamed of by the author of the "profitable treatise" mentioned; but the principles of book-keeping have not increased in complexity with the progress of commerce or the marvellous array of figures to be dealt with, as representing the amount of trade done in these later times. What has already been taught and exemplified in the foregoing lessons might fully enough enable any clerk to make any entry business might require him to insert in any of his books; but as our desire is to make this course as thorough and complete as possible, we add here a brief formal set of rules for Balancing Books.

"Posting"—being, as has been explained, the carrying of duly classified entries from some special book (which may practically be Day Book, Cash Book, &c., but in theoretical book-keeping is the Journal) into separate and distinct accounts opened in the Ledger—is of two kinds: (1) *Simple*, when there is one debtor and one creditor, as in Goods Account, p. 1284; (2) *Compound*, when there are one debtor and two or more creditors, or *vice versâ*, as in Sundry Accounts (page 1284, cols. 1 and 2). "Balancing the books" is the correct posting of each of the balances in each of the accounts in the Ledger, so as to put on record the *assets* and the *liabilities* of the business of which the transactions are recorded in the books. Of course there is one arbitrary rule binding in every form of book-keeping—viz. that every transaction must be recorded somewhere, and be posted to some account either in the Ledger or in some other book. While, however, any variety in the form of recording business transactions may be adopted which best suits the requirements of each specific concern, it must be such as is adapted to furnish a clear, just, and accurate record of the transactions which have taken place between trader and customer, and is capable of yielding, when thoroughly carried out, a certain and unerring guide to the attainment of true results.

In proceeding to attain a distinct view of these results at any fixed (or requisite) period, it is customary to strike

a *trial balance*. This may be done in two ways: (1) Add the entries on each side of the Ledger (of course excluding balances), and bring down on a sheet of paper, prepared for the purpose, the debit summations in a column on the right, and the credit summations on the left. If these columns agree in their summing and balance each other, the entries are (presumably) correct. If they disagree, the error must be sought till found. (2) Strike the balance on each account, bring down the differences on the sheet, placing them in proper columns. These when "totted" up should agree in their summations, and if they do not, the error must, as before, be searched out.

The trial balance-sheet having been found to be (presumably) correct, the next work to be engaged in is to make up and arrange the cross or closing entries. This is a most important step, and must be very carefully taken. Its objects are—(1) to find the actual assets representing value, *i.e.* such as may be converted into cash—all of which are to be placed on the left-hand side of the balance-sheet; and (2) to find the actual liabilities, which form a charge on and must be paid out of the assets, which are to be placed on the right-hand side of the balance-sheet. Any accounts which do not furnish entries of either of these sorts must be written off by a cross entry, *i.e.* by being carried, as the case may be, to the debit or credit of the profit and loss account. For example, in the stock or goods account—on which, obviously, profit may be gained or loss incurred—when the value of the goods or stock has been brought down as asset balances, the difference is written off, *i.e.* if there has been a profit it is carried to the right, and if a loss it is carried to the left of the profit and loss account. In balancing these accounts the following directions may be found useful:—

(1) Ledger [or personal] accounts are closed by carrying their balances to the debit or credit of the balance account.

(2) Real accounts require a double balance: (i.) each must be credited with the value of goods, stock, &c. on hand, *i.e.* in possession undisposed of at the time of balancing, and the balance account must be debited with the same amount; and (ii.) the balance then remaining—being the profit or loss—must be transferred to the profit and loss account.

(3) The Cash Book accounts are closed simply by transference of the balance to the balance account.

(4) Rent and taxes, salaries, wages, commission, discount, interest, charges or trading expenses, bad or doubtful debts, &c., have, where accounts are opened under these heads, their debit or credit balances transferred, as the case may be, to the profit or loss account.

These several processes having all been duly attended to, no entry should remain in the balance-sheet except genuine assets on the one side and real liabilities on the other. These are therefore to be brought down into the balance account, when, if the assets exceed the liabilities, or *vice versâ*, it should be exactly to the same amount as the balance of the profit and loss account, and that being taken down and entered on the less side squares the account. The difference between the assets and the liabilities indicates either, (1) the capital in the business, if on the right side; or (2) the net liabilities of the concern, if on the left.

A careful comparison of the manner in which the preceding "Transactions of William King" have been balanced on pages 1196–97, will show how these rules affect entries, and lead the student to value them as real deductions from the actual processes of business book-keeping.

It may be noted here that in recent years the use of a periodical—*i.e.* weekly, monthly, quarterly, &c.—balance-book has been introduced into many businesses. Such a book is divided into two parts—in the first of which the debtor, and in the second the creditor, accounts for each period are entered. On looking at this the tradesman can see at a glance the state of each account at any fixed time, and the book-keeper is able more easily to detect any error which may have occurred in posting. The following is a specimen of such a book:—

Debtor Accounts.	Folio.	January.	February.	March.	Creditor Accounts.	Folio.	January.	February.	March.
		£ s. d.	£ s. d.	£ s. d.			£ s. d.	£ s. d.	£ s. d.
Peter Brown, . .	63	371 4 8	27 1 3	154 18 1	Andrew Duncan,	132	407 2 2	191 6 10	598 11 7

It requires also to be observed that the Legislature has now made it a misdemeanour to carry on any business without using and making up such books of account as are either, (1) usual in the business followed, or, (2) sufficient to record all transactions and to afford the means of following out the course of business and discovering a trader's financial position; and it requires, in the case of bankruptcy, that these books, for three years preceding a failure, shall be produced. The importance of the study of book-keeping, and the attainment of practical skill therein, is not only sufficiently obvious in itself, but is greatly increased by this fact.

GERMAN LITERATURE.—CHAPTER III.

PHILOSOPHY—THEOLOGY—CRITICISM—HISTORY—IMAGINATIVE LITERATURE.

KANT's doctrine of rationalism as the law of thought, and nationalism as the law of life, was developed by his "Critique of the Practical Reason" so as to give scope to individual being within the limits of a principle which might be made the ground of universal legislation. It awakened Europe. Johannes Schulz became its earliest popular expositor; Karl L. Reinhold, with the devoted zeal of an apostle, proclaimed the new philosophy of consciousness which realized the *Ego* as the very outgrowth of law. Schiller, with the ardour of a poet and the genius of a philosopher, pressed the claim of the "Critical Metaphysics" on the minds of the cultured. F. H. Jacobi, fascinated by Spinozism, maintained the need of faith as a conviction of reality before man could colligate in thought his inward thinking nature with outward experience. In the secrecies of the mind and in the abysses of the heart there was a felt contradiction between the desires of man and the requirements of the external world, and this thesis he supported not by philosophical disquisition alone, but also in his shrewd and lively philosophical novels. T. G. Hippel, in his "Lebensläufe"—a curious and humorous novel—first popularized Kant's metaphysics; and J. G. Hamann, with a more marked leaning towards faith, followed Kant's speculative method. Jacob Fries maintained that just as the "things seen" are the objects of knowledge, "things unseen" are the objects of rational faith, every sentiment of which must rest on some indwelling presentiment. J. S. Beck endeavoured to show that experience of things in themselves did not affect us, but gave us rather such impressions as affected us, and that ideas of time and space do not pre-exist, but arise, as thought in us, as results of experience. C. G. Bardili averred that active thought pervades the universe, becomes consciousness in man, lifts life into personality, and makes the laws of phenomena the laws of mental association in us—*i.e.* constitutes science. Thus the philosophy presented by Kant as a finality—symbolised as an owl with her wings tied—far from bringing all speculation to an end, elicited quite a new manner of philosophizing. This was markedly instituted by J. T. Fichte, who wanted not dogmatics, but science—a doctrine of the necessary relations and connections of the whole realm of thought. In his "Wissenschaftslehre" he outlines such a philosophy. The *Ego*—*i.e.* our own self—we know; and the *Non Ego*—*i.e.* things in themselves—we know as experience. Each limits the other. As thinking develops, the outer world is subdued by thought into science, and by art into utility. Thus all categories are deduced, cause and effect become perceptible, and morality—*i.e.* the conservation of the rights of each individual—is made plain. The inductive activity of the *Ego* yields both philosophy and science. Besides earning the character of "the consistent Kant," Fichte gained great power as an advocate of the regeneration of the German nation. In his "Destination of

Man," "Vocation of the Scholar," and "Characteristics of the Present Age"—all available to English readers in William Smith's fine renderings—he brings out certain points of this theory; but in his "Addresses to the German Nation," with intense patriotic fervour he roused the land to enthusiasm. F. W. J. von Schelling elaborated Fichte's egoism into the threefold identism of theory, practice, and art—(1) the reduction of experience into the forms of thought, as science; (2) the impressing of form on matter, as industry, &c.; and (3) the intentional union of form and matter in representation, art, sculpture, painting, poetry, the drama, &c. Friedrich von Hardenberg, an original-minded poet—as in "An die Nacht" and many other *geistliche lieder*—and an imaginatively inventive novelist—as in his (unfinished) art-fiction, "Heinrich von Ofterdingen," and his beautiful "Mährchen"—stirred by Fichte and inspired by Schelling, interpreted idealism with dreamy yet fervent religionism. Franz von Baader gave it a more distinct theosophic turn, and C. F. Krause, especially in his "Das Urbild der Menschheit," advanced the opinion that all experience is seen in and interpreted by man through God. Then arose G. W. Hegel (1770–1831), creator of the system of absolute idealism. Thinking is self-evolution. We cannot think without *being*. But each definite conception involves its opposite, without which it could not be determined. In due succession the moments of thought originate all the categories of logic, these in the several opposites which necessarily flow out of them realize themselves and are reconciled one with another in nature, and by a similar series of transitions reveal mind, and if we choose to go further, the mind in nature, which is the ultimate of logic, *i.e.* God. God is the absolute *other* of individual mind, and nature the necessary *other* of logic. The thought is brilliant, the acumen searching, and the tracing out of the course of thinking curious and suggestive, but the language is a lexicographic wilderness of strange terms. Dr. James Hutchison Stirling's exhibition of "The Secret of Hegel" explains much of the mystery of the system, and gives great help towards comprehending its terminology. F. E. D. Schleiermacher (1768–1834) attempted the rôle of reconciler of the realistic and idealistic intellectual functions of thinking men. Space and time are forms of things, not ideas. The categories are valid for experiences; but as man is both inceptive and receptive in thought, there is a co-operation between the *a priori* of initiation and the *a posteriori* of observation, of the power experiencing and the thing experienced. The thinking mind is a totality, the experienced world is a totality; but Deity is the unity of the universe and the object of duty. In this religion has its root. Duty varies in kind and amount, but not in ground, with individuality, which is the measure of responsibility. In his theological relation we may note that his "Course of Lectures" on the life of Jesus led to the undertaking of "Das Leben Jesu" (1835) by D. F. Strauss, and "Der Christus des Glaubens und der Jesus der Geschichte" (1865)—a criticism of Schleiermacher's "Lectures."

Arthur Schopenhauer (1788–1860) provided a transition from Kant's idealism to a fresh realism. His doctrine, set forth in "Die Welt als Wille und Vorstellung," is, that objects are only impressions of the real made by ideas on the thinker's mind, and are therefore phenomena for which the categories are valid. Consciousness manifests itself as will, which is the sole reality. The will to live is active, but the world tends constantly to destroy and interfere with it, and hence the world is not the best but the worst of theatres in which to breathe "thoughtful breath." J. F. Herbart (1776–1841) defines philosophy as the understanding of conceptions. Logic clears, metaphysics corrects, while ethics completes them as duty, and æsthetics as products. Pedagogy and psychology are instrumental methods, politics are self-conservative agencies, and theology is the sum of the ethical relations, when the extension of experience has been brought to arrest by the intension of thought. Space, time, and the categories are formal conceptions forced on mind by phenomena. Culture increases intensity of being and diminishes the force of the outward on the spirit. F. E. Beneke (1798–1854) asserts that through consciousness we know ourselves, and by it we apprehend phenomena—(1) appropriating impressions, (2) forming faculties, (3) transferring impressions and faculties, and (4) attracting and blending them. This is his "Neue Grundlegung zur Metaphysik;" but his "Lehrbuch der Psychologie als Naturwissenschaft" presents his principles in their most precise form. He has been largely influential in education and teaching through his "Erziehungs und Unterrichtslehre," "System der Logik," and "Lehrbuch der pragmatischen Psychologie." J. G. Dressler, in his "Praktische Denklehre," is the most enthusiastic disciple of Beneke.

It is unquestionable that the theologians of Germany have infused fresh vigour and a new spirit into the investigative study of the Scriptures. Intellectual keen-sightedness into historic connection and relation, subtle analysis of lexicograpic results, singular acumen in tracing the turnings and windings of Hebrew thought, and a wonderful power of setting the literature of Israel in suggestive surroundings, have all been applied to the criticism, comprehension, and exposition of the sacred volume. Theological reading, however, is rather pursued in a professional course, and confined very frequently to the adherents of specific schools, and such books are not often perused as literature. Yet in Germany such works excite great interest, and frequently rival in popular run the novels of the day. Schleiermacher and Strauss have already been named, and we may here note the learned and rationalistic De Wette, whose "Translation of the Scripture" (1831), and "Exegetical Manual of the New Testament" (1836–40), pioneered the way for many an erudite follower. Few students of German will be likely to regale their minds with the thirty-nine volumes of L. F. Theremin's "Sermons" (1836), famous orator as he was, and while only a few will task themselves to peruse Neander's extensive "History of the Christian Church," many might wish to read a few of his monographs—*e.g.*, "Julian," "St. Bernard," "St. Chrysostom," and the "Life of Christ." Karl Ullman is favourably known by "The Sinlessness of Jesus" and "The Essence of Christianity," but his "Judas Iscariot," an endeavour to solve the mystery of evil, "Historisch oder Mythisch," a reply to Strauss and his "Reformers before the Reformation," uphold his fame. Umbreit is celebrated as a commentator on the Old Testament and author of many excellent poems founded on its text. F. Tholuck's "Hours of Devotion" was highly popular. Dr. C. Nitsch's "System der Christlichen Lehre" is full and clear. Gieseler's "Church History" is very valuable. R. Rothe's "Theologische Ethik" is a fresh treatise. Karl Daub is reckoned the founder of Protestant speculative theology. Wegschneider and Gesenius are representatives of old rationalism. C. A. Hase sought the reconciliation of the antique faith with modern science. F. Bleek became an authority on Biblical Exegetics. J. C. E. Schwarz was held in honour as a preacher, critic, and scholar, and has composed interesting *Denkschriften*. Dr. Lücke's splendid commentary on St. John's writings is well known. Schenkel, Schweitzer, Dorner, Hundeshagen, Bayrhoffer, Bruno Baur, F. C. Baur, J. C. Schwab, and a thousand others, might be named, but cannot be characterized as theologians of marked repute in the ecclesiastical records of Germany.

Since Lessing, in his "Literary Letters" (1759–65) and Laocöon (1766), replaced empirical by scientific criticism, Germany has signalized itself by its critical school. The two Schlegels, in "Das Athenæum," organized and applied the principles by which every claimant of literary creativeness should be judged. The philosophy of Fichte furnished them with congenial ideas, and they became the imitators of the "Schonwissenschaftliche Kultur." Entire sections of the literature of the past—Greek, Roman, Italian, Spanish, French, English, and German, as well as that of many of the Oriental languages—were brought under review. Their *belle-lettre-ism* did not satisfy everybody, and retaliatory controversy was awakened. Indeed German philosophy, history, and theology are "nothing if not critical." A. W. Schlegel (1767–1845) translated Dante, Shakespeare, and Calderon, composed sonnets, elegies, *romanzen*, and dramas, while he reviewed a vast extent of the book-world in his "Lectures on Dramatic Literature and Art." K. W. F. Schlegel (1772–1829) exhibited wide erudition and profound philosophy in his historico-literary lectures, "Geschichte der alten und

neuen Literatur," "Philosophie der Geschichte," "Philosophie des Lebens," "Philosophie der Sprache und des Wortes," &c. Next to be named are the brothers Jacob L. Grimm (1785–1863) and Wilhelm K. Grimm (1786–1859). The former is immortal for the industry, perseverance, and success of his philological and historical researches regarding the literature and language of his native land—on the mythology and grammar of which he has written profoundly, as well as "Ueber den alten Meistergesang." His "Deutsches Wörterbuch" is a monumental work. The latter is known by his "Heroic Legends," "Ancient Danish Heroic Poems," &c. Both brothers have made themselves the child-friends of all time by their "Kinder und Hansmahrchen." More illustrious even are K. Wilhelm von Humboldt (1767–1836), an eminent statesman and the philologer who has really originated the proper philosophic study of the several orders of human language, and F. H. Alexander Humboldt (1769–1859), whose travels, researches, and scientific survey of the "Kosmos" have excited the gratitude of the learned of all lands. G. G. Gervinus (1805) has in his "Geschichte der poetischen National Literatur der Deutschen" traced the development and progress of German poetry. His "History of the Nineteenth Century" is much approved, and in his "Shakespeare Commentaries" there will be found the most comprehensive contribution to the analytical criticism of that poet which Germany has supplied, although there appear among the German students of Shakespeare H. Ulrici ("Shakespeare's Dramatic Art"), F. Kreyssig ("Vorlesungen"), H. T. Rötscher ("In Seinenhöchsten Charakterbilden"), H. Heine ("Mädchen und Frauen"), Karl Elze ("Essays"), F. Pecht ("Shakespeare Galerie"), N. Delins, Julius Thümmel, W. König, F. Silberschlag, R. Genèe, C. Muerer, K. Göedeke, Benno Tschischwitz, Otto Ludwig—named not in order of date, but as they rise in memory, yet leaving hundreds unnoted, among which are Goethe, Horn, Simrock, A. Schmidt, &c. Wolfgang Menzel, though an excellent writer and a man of genius, is frequently partial and far too sweeping in his "Geschichte der deutschen Literatur."

The historians of Germany are as a general rule painstaking, researchful, informing, and thoughtful. They carry their weight of acquisition sometimes rather clumsily, but they never fail to bring to light fresh material and intelligent appraisal of them. Their "name is legion." Lappenberg's "History of England under the Anglo-Saxon Kings" (1834–37) eclipsed all previous works of the kind, and roused the rivalry of British writers. B. G. Niebuhr (1776–1831), produced a masterpiece of research and veracity in his "Romische Geschichte," though Theodor Mommsen's more recent (1858–62) monumental work has excelled it. The "Griechische Geschichte" (1857) is for Hellenic history an equally remarkable issue of classical study. A. H. L. Heeren's "Ideen über die Politik," was an epoch-making book in philosophical history. J. von Müller (1752–1809), the German Tacitus, bears a historic reputation in Switzerland, of which he was a native, and Germany. H. Ludens, J. C. Pfister, F. C. Dahlman, and Gervinus have made original researches into the sources, and regarding the progress of the German people. H. Leo gave an instructive history of Italy; Leopold Ranké in the "History of the Romanic and Germanic Nations," "Princes and People of the Sixteenth and Seventeenth Centuries," but especially in his "History of the Popes," won world-wide reputation. Raumer's "Hohenstauffen Dynasty," Vogt's "History of Prussia," Maylath's "Austria" and "Hungary," Duncker, Preuss, Böttiger, Hausser, Von Sybel, Waitz, and a host of others, might be named. In special departments there are Wagner on music, Sprengel in medicine, Gmellin in chemistry, Staudlin in theologic science, Rode and Munter in ecclesiastical history, Erdmann and Ueberweg in philosophy, Mayer on military affairs, &c. Science has a literature for itself; biography has been richly cultivated; geography since the days of Ritter has acquired immense treasure-stores of books; while the manuals and encylopædias of Germany grow in dimensions and importance year by year. German literature is both fruitful and faithful.

The imaginative literature of Germany differs widely from ours, especially in its fictions. One of the most notable influences on the Teutonic mind was that exerted by De Foe. For half a century its presses issued *Robisonades* and *Avanturies—e.g.* "Wenzel von Erfurt" (1788), and "Die Insel Felsenburg" (1743). The latter was re-edited 1825 by Ludwig Tieck (1773–1853), the son of a ropemaker at Berlin and of a fine hymn-book loving mother. His teacher inspired him with the love of reading. Don Quixote he prized, Shakespeare he idolized, Rousseau unsettled him, Goethe's "Faust" restored him to sanity, and he became *der deutscheste Dichter*. He collected the German Minnelieder, 1803. Under the pseudonym of Peter Lebrecht he issued his "Volksmärchen." His "Genoveva," "Fortunatus," and "Octavianus" are *chef-d'œuvres* of the romantic drama. His (unfinished) novel "Franz Sternbald" did much to awaken correct ideas on art. "Der Aufuhr in den Cevennes," "Das Dichterleben," and "Victoria Accorambona," if not quite so exciting as "Abdallah" and "William Lovell," are his best fictions. Ludwig J. Arnin (1781–1831) wrote "Die Gräfin Dolores," an artless, droll, thoughtful, clever book; "Isabelle von Egypten," a charming and with a slight exception an elevating work; "Angelica und Cosmus," founded on fact; "Die Kronenwachter," a tale of Maximilian's times; and he co-edited with Clemens Brentano (1777–1842) "Des Kuaben Wundeshorn," a collection of old ballads, songs, &c. Brentano's best work is not his "Godwi," but his "Goekel, Hinckel, and Gackeleia." His sister, who was Arnin's wife, realizes the union between poetry and life in "Goethe's Briefwechsel mit einem kinde." It has been read as if a true chapter of the poet's life. F. de la Motte Fouque (1777–1844) revives the era of song and chivalry in his beautiful "Undine," "Theodolf der Isländer," and "Zauber-ring." Karl Lappe's "Friedhofkränze," a collection of old poems on death and the grave, as well as his "Klein's und Gulliver's wunderbare Reise" (1832), and Joseph von Eichendorf's poems and stories, still retain the public liking. Caroline Pichler's "Agathostes," "Die Schweden in Prag," "Die Belagerung Wiens 1683," "Die Grafen von Hohenberg," &c., prove her to be an excellent historical novelist. Many of her shorter tales are very suitable for using as studies in German—*e.g.* "Der Pflegesohn" and "Die Stieftochter." A. R. K. Spindler is always careful of his story and its environments. Zschokke's *novellen* are lively in narrative and pleasing in style. Willibad Alexis (really Häring) was an imitator of Scott; his "Der Roland von Berlin," "Herr von Sacken," and "Rosamunde" are well got up. Ida von Hahn-Hahn, and Johanna Schoppenhauer, the metaphysician's mother, write pleasingly. Auerbach, Freytag, and many other writers of fiction illustrate the literature of united Germany.

Nearly eighty-three years swept past in the interval between the birth of Johann Wolfgang von Goethe, 28th August, 1749, at Frankfurt-on-the-Maine, and his death at Weimar, 22nd March, 1832. His was a life thrilled by strong emotions and great thought, yet marvellous for its cool self-mastery. The greatest name in German literature is undoubtedly his. Variousness, originality, influence, and high gifts united to successful æsthetic culture are acknowledgedly his, although he is wanting in historic conceptiveness and dramatic realization. Goethe's earliest drama, "Goetz von Berlichingen" (1773), is known as a boldly executed original version by everybody through some translation, probably Sir Walter Scott's. His leaf from the book of his own life at Wetzlar, "The Sorrows of Werther," albeit namby-pambyish, in 1774, stirred Europe to ecstasies. His dramas "Clavigo," "Egmont," "Tasso," and "Iphigenia" were prepared among many others for the ducal theatre at Weimar; the two former are in fine free prose, the latter well imitated classical antiques. Carlyle's reproduction of "Wilhelm Meister" (1794) has made available to most readers that philosophic novel, full of the slippery morality which characterized the greater part of the author's career. He was a readily moved, but not an intense lover, lived in a way that jars on moral feeling, and hesitated much to inclose his passions within the golden circlet of a marriage-ring—though he ultimately did so in 1806, that he might legitimate his heir, born 1789. "Faust," though begun in 1769 and the first part of it issued in 1790, was not completed till, by the production of the second part, Goethe undertook to unravel to the reader

the hidden meaning of this drama of the brightest and best intellect, world-worn, tempted, "toiling, rejoicing, sorrowing" and causing sorrow, passing into dreams and aimless enjoyment, leaving utilities for futilities, and masquerading through much folly till at last he finds that all is vanity and inanity, and then the heaven of wisdom, of joy, opens to him. The world recognizes the wonderful poetry of the former part, but not finding this (posthumous) continuation thrilling with the same life or thought scarcely regards it. The English reader has a wealth of translations provided for him. That of Hayward in prose, those of J. S. Blackie, Sir Theodore Martin, John Austen, Lewis Fillmore, &c., in verse, can be commended. The second part has been racily and harmoniously translated by the late Wm. B. MacDonald of Rammerscales. "Faust" is really a series of scenes rather than a drama. Its significance in European literature is singular, and quite a Faust library has accumulated around it seeking to explain its mystery. Perhaps the simplest is that its incidents are introspective feelings and situations externalized in fancy. Few Germans profess to fathom its depths, but all feel its grasp on the intellect and the emotions, and the proof it yields of the proverbial old Greek consociation μαθήματα παθήματα.

Goethe's sweet modern idyllic epic "Hermann und Dorothea" (1798) has been issued in pellucid English by William Whewell. It is a fine pure domestic tale of middle-class burgher life, and is exquisite in tone, keeping, and style. The inward disease of emotional nature from which Goethe suffered appears with sufficing markedness in his "Wahlverwandtschaften" (Elective affinities), and in his autobiographic writings. In G. H. Lewes, "Life and Writings of Goethe" the most complete extant study of the man in all his relations, actions, and labours, and of the author in all his thoughts, plans, and achievements, will be found done by a writer of like sympathy and many-sided culture. Goethe's works are numerous, and embrace all sorts of literature as well as many departments of science—*e.g.* geology, optics, the theory of colour, and the metamorphoses of plants. His prose is calm, graceful, and clear; his verse fresh, living, and spontaneous. Life and the world are set to music in his works. If the German language possessed only Goethe and Schiller, Kant and Hegel, Richter and Lessing, the study of it would be amply repaid.

J. C. F. Schiller (1759–1805), while Goethe devoted his genius to the putting of realities into poetic form, laboured assiduously to impart reality to his ideas. Both Carlyle and Lord Lytton have made the main incidents of his life and the chief characteristics of his writings readily available. His eagerness to impart realistic existence to his thoughts induced him—stirred by the study of Shakespeare—to dramatise. "Die Räuber" (1781) is the young enthusiast's picture of the revolutionary era of vice opposed by vice, and sin by sin. He was interdicted from writing other dramas; but the charm of creative energy was irresistible. "Fiesco" (1783) and "Kabale und Liebe" (1784) were his next ventures. The former is founded on a Genoese conspiracy against the Doria in 1547; the latter is directed against the *Adelstand*, and refers to circumstances that had occurred during his unpleasant student life in Stuttgart. Hitherto literature had been his aspiration, now it became his occupation. "Don Carlos" (1786) gave earnest, in beautiful and tender scenes, of a fresh spring of thought, though in the terrible close the old Schiller is perceptible. His studies of the period of this hero for the play, which already had given to Otway (1672), to Campistron (1683), and Chenier (1789) in France, as well as to the Italian Alfieri in his "Filippo" (1778), the materials of splendid dramas, led Schiller into history, and the result was "Die Geschichte des Abfalls Vereinigten Niederlande" (1788). His "Der Menschenfeind," "Der Geisterseher" (incomplete), and "Der Verbrecher aus Verlorner Ehre" are tales belonging to the same period—all marked rather by singular psychological fascination than plot-interest. History again supplied him with incitement and material for making poetry a mirror of bygone times, customs, and incidents. In the grand dramatic trilogy, "Wallenstein" (1799), he puts into fluent iambics the characteristic thought and action of Germany during the period of the Thirty Years' War, of which, in 1791, he issued a history. In this he applies the rich and harmonious diction and the vivid imagination of the poet to the illustration of the annals of the Fatherland. Through Goethe's influence he had previously been appointed professor of history at Jena. For "Maria Stuart" (1800) Schiller found in British history a tragic situation at the cross-roads of Popery and Protestantism full of interest and instruction. Goethe condemned as going beyond dramatic license Mary's confession and her partaking of the communion on the stage. False to real history by alteration and transposition of facts, he has made the lessons of the time apparent. "Die Jungfrau von Orleans" (1801) realizes the apostle of patriotism, the inspired *paysanne* of Domremy, with great power. The poetic brilliancy of many parts of that drama is unmatchable. "Die Braut von Messina" (1803), antique in form and romantic in plot, is remarkable for versification and characterization. With the animated, soul-stirring, poeticized history of "Wilhelm Tell" (1804), the dramatic career of a worthily famed dramatist may be said to have closed with brightened glory. In Schiller's short life of forty-five years he produced a wonderful amount of work. In philosophy he laid the foundations of a new theory of æsthetics and poetic art in his "Briefe über die Aesthetische Erziehung des Menschen" and "Ueber naiv und sentimental Dichtung" (1795), which revolutionized in Germany the whole fabric of artistic and literary criticism. German literature has scarcely anything more perfect than the lyrical compositions of Schiller; the grand simplicity, finished loveliness, varied metre, sagacious thought, and marvellous exposition of human feeling, desire, and passion make "Das Lied von der Glocke" an immortal masterpiece; the charm of nature over the soul has been surpassingly enshrined in "Der Spatziergang;" and "Die Macht des Gesanges," "Der Ring des Polykrates," "Hero und Leander," "Kassandra," "Die Kraniche des Ibykus," and one might easily quote others in scores, display the splendid faculty of realizing in words of beauty ideas of worth and moment. Goethe, only a short time after Schiller's death, wrote thus sorrowfully of his intimate friend and fellow-poet, who had, in the prime of life and the lustre of his genius, passed suddenly away:—"Ich dachte mich selbst zu verlieren, und verliere nun einen Freund, und in demselben, die Hälfte meines Daseins."

Of Schiller's minor poems many admirable versions have appeared, so that even the English reader would find it a delight to compare—as he may do by reading in James Clarence Mangan's "German Anthology" (1845, pp. 1–81, Vol. I. and pp. 1–30, Vol. II.)—the chief ballads and lyrics of Schiller and Goethe, who in friendly emulation strove by many admirable poems to refine the poetic forms of German expression and quicken the ideal in the Teutonic nation. But a more thorough and gratifying critical comparison may be made by the perusal of the masterly renderings contained in "The Poems and Ballads of Goethe," by Professor W. E. Aytoun and Sir Theodore Martin, and "The Poems and Ballads of Schiller," by Edward L. Bulwer Lord Lytton, or the "Poems of Schiller," by Edgar A. Browning; the latter contains translations of every piece in the authorized editions, and the fine dramatic sketch of "Semele" in two scenes. Coleridge's version of "Wallenstein," though not entirely faithful to the text, is almost always equal to, and occasionally somewhat better than, the original. The student of German will find the study of "The Song of the Bell"—on which its author laboured from 1797 till 1799—an excellent poem upon which to expend study for its large vocabulary and felicity of phrase, its variousness of versification, and the adaptation of rhyme and rhythm to meaning and emotion.

These are the greatest names in German literature. The Jove-like self-sufficiency of the one and the Herculean might of effort of the other have not yet been surpassed. We must now descend to meaner, though yet very distinguished men.

J. L. Uhland (1787–1862) has essayed every species of poetry, but in none has he succeeded better than in ballads and romances. In these domains he holds a place little inferior (if any) to that of Goethe and Schiller in truth and depth of feeling, power over the heart, in ornate yet melodious diction, and distinctness of conceptive creation with swiftness of narration. His "Ludwig von Bayern" (1819) and "Ernst von Schwaben" (1817) are fair poems, but they are not pene-

trated with intense life, as dramas require to be. "Walther von Vogelweide" (1822) is a critical work of considerable value; "Ueber den Mythus der Nordische Sagenlehre vom Thor" (1836) sets forth in a very carefully composed scholarly work the legend of Thor; and "Alter hoch-und nieder-deutsche Volkslieder," a collection of the popular songs of Germany, exhibits fruits of his professorship of German literature at Tübingen. But eagerly national, his Burns-like patriotism flashed into song denunciatory of the Napoleon-led invaders of the Fatherland. These songs, by their impassioned fervour and earnestness, stirred the spirit of the people, and the picturesque manner in which, in such pieces as "Klein Roland," "Roland Schildträger," "Goldschmidt's Töchterlein," "Der Blinde König," "Taillefer," "Das Nothhemd," and "Graf Eberhard der Rauschebart," to mention but a few almost at random, are quick with pure, fresh, poetic vitality. Had he been less a patriot immersed in political struggles we might have got more, but not finer, work from him. In 1857 his fellow-countrymen made him the object of an enthusiastic ovation, so enraptured were they with the manner in which he had made legend, history, and everyday experience brimful of national life. Andreas J. Kerner has woven his thoughts into dreamy, fantastical, and melancholy songs, and Schaumann, by fitting them with suitable melodies, has heightened alike their charm and their popularity. How wild, weird, solemn, and expressive are "Rath im Mai," "Schusucht," and "Waldleben!" and in those poems where the thrilling scenes of death are placed before us, as in "Zwei Särge" and "Kaiser Rudolff's Ritt zum Grabe," how plaintively sad! and yet in his "Wanderlied," "Frühlingsmorgen," "Sängers Trost," "Der Wanderer in der Sägemuhle," and his "Trinklied," how lightsome and merry! The striking creations of the "Reiseschatten" are quaint and queer. He has told besides many strange tales, and for a while held Europe in thrall with his "Seherinn von Prevorst." He has issued several medical and mystical writings, as well as an autobiography. His last years were passed in sightlessness. His son Theobald is also known as a popular song-writer and vigorous poet. F. Hölderlein enchased the pure antique Greek from the realities of modern experience, but his own sad life darkened into insanity. Ernst Schulze's low, soft, plaintive voice recalls the charms of the Minnesingers. Louis C. A. Chamisso (1781-1838), though French by birth, and fancifully allegorizing his grief as an exile in "Peter Schlemhil" (1814), is a distinguished German lyrist, as his "Das Schloss Boncourt," "Die Blinde," "Die Alte Waschfrau" will show. His "Reise um die Welt" is informing and interesting. His translations from many languages are charmingly true. Annetta E. von Droste-Hülshoff (1797-1848), in originality of form and matter, and grandeur of poetical expression, combined with versatility of talent, more than rivals Chamisso. Zedlitz's "Waldfraulein" and "Todtenkranzen" deserve high admiration. W. Menzel's "Rübezahl" is an effectively rendered romance. Wilhelm Müller (1794-1827) set Hellas on fire with his "Lieder der Griechen." He issued a "Blumenlese aus den Minnesanger" (1816), a version of Marlowe's "Faustus" (1818), and many other tales, poems, historical sketches, &c. Our widely cultured linguist and philosopher, F. Max Müller, is his son. Anastasius Grün (Count Auersberg), in a fresh though not flexile style, composed national lyrics, political squibs, and humorous rhymes like "Der letze Ritter," "Schutt," "Nibelungen in Frack," &c. Nikolas Lenau (1802-50), whose poetic aspirations "in his pained heart made purple riot," issued his "Faust," 1837; "Savonarola," 1839; "Die Albigenser," 1842; and closed his days in a Viennese madhouse. Wackernagel, Simròck, and Hofmann reproduced and imitated the old popular German poetry. Wilhelm Hauff (1802-27), besides being a prolific story-teller—*e.g.* "Die Lichtensteiner," "Der Mann im Monde," "Das Bild des Kaisirs," and many *mahrchen*—was a sentimental imitator of the early lyrists. The love-songs of R. Reinick are arch and naïve. August Kopisch is a happy original humorist—*e.g.* "Die Heinzelmännchen," "Als Noah aus dem Kasten ging," &c.; Franz Gaudy's "Liebeslieder" are suggestive of Heine, but his versions of Beranger are good; and E. Geibel writes delicately and with imaginative capacity both poems and romances. F. Freiligrath, as John Oxenford has shown in English, with fresh and vigorous genius has struck the lyre of the patriot with a master's hand. Besides his own bright-coloured poems, his translation of Burns deserves British gratitude and praise. Heinrich Heine (1797-1856) has been called by Matthew Arnold "the chief romantic poet of Germany," "noteworthy because he is the most important German successor and continuator of Goethe in Goethe's most important line of activity"—*i.e.* as "a soldier in the war of liberation of humanity." The reader should resort to that unrivalled essay, and learn from him to realize the tender grace, the wonderful interest, the brilliant wit, the fantastic ideality, the cheerful vivacity, and the ever-looming melancholy of the strains of this Spinoza of poets. What a pleasure it would be to recall Theodor Körner, the poet of the "Sword and Lyre;" the happy yet idiomatic finish of H. Laube; the harmonious versification of Theodor Mundt, a leader in the *Junge Deutschland* school of writers, who has put "Die Magie des Lebens" and the sorrow of the Madonna not only into his verse, but his novels; and the soul-stirring strains of Moritz Arndt, not to speak at all of the singers who sweeten the living present of Germany with thought set to music! But in vain. As memory sweeps over the vast field of German literature she sees the ripe treasures of its fields scarcely the poorer for the gleanings which we have here made of the "carle stalks" of German genius.

CHEMISTRY.—CHAPTER XVIII.

ANALYSIS OF DRINKING WATER—MATTER IN SUSPENSION—DETERMINATION OF AMMONIA—NESSLER'S TEST—FRANKLAND AND ARMSTRONG'S TEST FOR CARBON AND NITROGEN—DETERMINATION OF TOTAL SOLUBLE MATTER—AMOUNT OF CHLORINE IN WATER—HARD AND SOFT WATERS—SOAP-DESTROYING POWER—PREPARATION AND STRENGTH OF SOAP SOLUTION—TABLE OF HARDNESS—DETECTION OF LEAD, COPPER, SILICA, IRON, LIME AND MAGNESIA, PHOSPHORIC ACID, SODIUM, AND POTASSIUM—PURE RAIN WATER—ANALYSIS OF GUANO—DETERMINATION OF MOISTURE, FIXED INORGANIC MATTER, INSOLUBLE MATTER, PHOSPHORIC ACID, LIME, ETC., IN GUANO—PREPARATION OF STANDARD SOLUTION OF URANIUM—DETERMINATION OF MAGNESIA, SULPHURIC ACID, NITROGEN AS AMMONIA, NITROGEN AS ORGANIC MATTER IN GUANO—ANALYSIS OF SUPERPHOSPHATES—BAUMÉ'S HYDROMETER TABLES—WATER ANALYSIS.

THE water to be analyzed should be collected in stoppered glass bottles, such as Winchester quarts, of about $2\frac{1}{2}$ litres capacity. Two such bottles will contain sufficient water for the purposes of analysis, unless an exhaustive examination has to be made, when double or treble the quantity may be required. Care should be taken that both the bottles and the vessels employed to fill them are perfectly clean, and that the water obtained is a representative sample. When the water is taken from a river or tank the bottles should be immersed below the surface, and rinsed once or twice with the water. When the water is obtained from a pump or pipe a considerable quantity should be allowed to flow away before the sample is collected. The bottles should be nearly filled to the neck and the stoppers tied down with string; neither luting nor sealing-wax should be used. Earthenware bottles are liable to affect the hardness of the water, as the clay frequently contains large quantities of calcium sulphate.

The first step is to fill a narrow cylinder of white glass with the water to be analyzed, and compare its colour with that of distilled water contained in a similar vessel. Then heat a portion of the water to about 30° C. in a wide test tube, and shake the liquid, noting if the water possesses any peculiar odour or taste. The question whether the water should be filtered or not before analysis depends upon the use to which it is put by the consumer. If the sample is to be filtered care must be taken that the filter paper is free from ammonia; it should be steeped in distilled water for some time before use and afterwards dried and folded, and heated in a weighed tube for some hours at 120° C., afterwards placed in the desiccator and weighed when quite cold. It is then inserted in a clean funnel and the filtrate received in a Winchester

quart. The quantity of water to be filtered is measured, and when it has passed through, the filter is removed and washed with distilled water, the washings being kept distinct from the filtrate, again dried at 120° C. for some hours in the stoppered tube, and weighed. The increase in weight gives the amount of total suspended matter in the known volume of the water. The filter paper is then burnt in a small platinum crucible and the ash weighed; the quantity in excess of that due to the filter paper gives the amount of suspended organic matter in the water. If the water is unfiltered, the bottle should be well shaken before removing the quantity intended for analysis.

In order to determine the ammonia, which, from its liability to change, should be done first, the method of estimation is based on the fact that an alkaline solution of mercuric iodide added to a liquid containing ammonia causes a brown colouration, due to the formation of the iodide of tetramercurammonium. This test, known as Nessler's, is so sensitive that one part of ammonia in 20,000,000 parts of water may be detected. The determination of the ammonia in water used for drinking is of great importance, since an undue proportion of this substance at once denotes contamination with sewage. Sewage generally contains from 2 to 10 parts ammonia in 100,000 parts of liquid: river water usually contains about 0·01 part more or less; impure well waters frequently contain as much as 0·5 to 1 part in 100,000 parts.

In carrying out the Nessler test the following preparations are necessary:—35 grammes of potassium iodide are dissolved in 120 c.c. of water, and 5 c.c. of the solution is measured off into a clean beaker, and to the remainder a cold concentrated solution of mercuric chloride is added little by little until the mercuric iodide ceases to be redissolved on stirring. The 5 c.c. of the potassium iodide is then added to redissolve the remaining mercuric iodide, and the mercuric chloride solution is cautiously added until only a very slight precipitate remains. An aqueous solution of potash is now added, prepared by dissolving 100 grammes of stick potash in 200 c.c. of water, and the mixture diluted to 500 c.c. This liquid should stand for a short time, and a portion be decanted into a small bottle for use. A standard solution of ammonium chloride is also required, prepared by dissolving 0·7867 gramme of pure ammonium chloride in a litre of distilled water. This solution should be labelled, "Ammonium Chloride Solution No. 1." From this solution 100 c.c. is taken and diluted to 1 litre. This is called "Ammonium Chloride Solution No. 2," and 1 c.c. of this solution contains ·025 of a milligramme of ammonia. This solution should be delivered from a Mohr's burette fitted with a glass stopcock, and graduated to tenths of a cubic centimetre. A small pipette to deliver about 1 c.c. of the Nessler test is likewise needed, which may be easily made from a short piece of glass tube; also six or seven glass cylinders of about 20 cm. in height and of 60 c.c. capacity, marked A, B, C, D, &c. These are graduated by transferring 50 c.c. of water to each, and marking the level of the liquid on the glass. Further, two or three pieces of thin glass tube, about 30 cm. in length and 3 mm. in external diameter, the ends of which are blown into bulbs of such diameter that they readily pass into the glass cylinder, the other ends being sealed.

The distilled water used must be tested for ammonia. One of the cylinders is rinsed with the water and filled nearly up to the top; add 1 c.c. of the clear Nessler solution, and agitate with one of the bulb tubes by drawing it up and down a few times within the cylinder. If after standing for a few minutes the water remains perfectly translucent, it may be considered free from ammonia. If it has a yellow or brown tint, re-distil it after adding about a gramme of pure sodium carbonate, and collect the distillate in a Winchester quart as soon as 50 c.c. received in one of the glass cylinders gives no reaction for ammonia on testing with the Nessler solution. When ordinary water is used the distillation must not be carried to dryness, and the residue should be thrown away before a fresh quantity is distilled.

The analysis of the water is now made in the following manner:—Transfer 50 c.c. of the natural water to be tested to one of the glass cylinders, placing it on a sheet of white paper, and add 1 c.c. of the Nessler solution, agitating with a glass bulb. Place 50 c.c. of the distilled water into another cylinder and add ·2 c.c. of ammonium chloride solution No. 2, mix thoroughly, and compare the colour of the two waters after the addition of the Nessler solution. If they are about equal in intensity, take half a litre for estimation; if the colouration in the natural water is more intense, take a proportionately smaller quantity. This test is simply preliminary, its object being to afford an idea of the proper quantity to take for the *actual* estimation. If the natural water becomes turbid after the addition of the Nessler test, a decided precipitate is due to lime or magnesia salts, and indicates *hardness*. Then place 500 c.c. of the water, or a less quantity if the preliminary testing has shown that ammonia is present in considerable quantities, in a capacious retort and connect it with a Liebig's condenser, which should be freed from ammonia by previously blowing steam through it for a few minutes. If less than 500 c.c. of water have been taken, the liquid in the retort must be made up to this quantity by the addition of distilled water before the distillation is commenced. Add about a gramme of recently heated and pure sodium carbonate, and observe if much precipitate is formed, and distil rapidly over the direct flame. Collect 50 c.c. of the distillate into one of the glass cylinders, A; when filled replace it by a second, B. When the second is full remove the lamp; add 1 c.c. of Nessler's solution to the second cylinder, B, of the distillate; agitate with a bulb, and place it on a sheet of white paper. Then fill up a third cylinder, Z, with distilled water to within a few centimetres of the level of that in B, and add as much standard ammonium chloride solution No. 2 as will bring up the same depth of colour as in B, and afterwards 1 c.c. of Nessler's solution; add a little distilled water if necessary, so as to make the levels in the two cylinders the same. Agitate again, and compare the tints. If the colour of the liquid in the two cylinders, after standing about five minutes, is equal, the amount of ammonia contained in B is equal to that contained in the volume of standard ammonium chloride solution added to Z. If the intensity in Z is not equal to that in B, pour away the contents of the former cylinder, rinse it, and fill it with a second portion of distilled water; add more or less ammonium chloride solution, as the case may be, and 1 c.c. of the Nessler test. It is necessary to throw the first liquid away, as after the Nessler test has been mixed with the water the addition of more ammonium chloride solution would cause a turbidity and prevent accurate comparison. If the quantity of ammonia in B does not exceed ·01 of a milligramme, equal to 0·4 c.c. of the standard ammonium chloride solution, the distillation may be discontinued; if the amount is greater than this the boiling must be renewed, and successive portions of 50 c.c. of the distillate tested until the above limit is reached. If the quantity of ammonia in B does not exceed that corresponding to 0·8 c.c. of the standard solution of ammonium chloride, the amount in A may be determined in the manner pointed out; if the quantity is greater than this, 25 c.c. (or less if need be) of the solution must be transferred to another cylinder, diluted to 50 c.c. with pure distilled water and treated as above. A colour produced by more than 4 c.c. of the ammonium chloride solution cannot be conveniently compared, as the liquid is likely to become turbid. In waters known to contain much ammonia, as in sewage, 100 c.c. should be distilled over at once into a larger cylinder, an aliquot portion withdrawn and diluted to 50 c.c., and treated as before.

The carbon and nitrogen contained in the organic matter present in water may be determined (by the Frankland-Armstrong process) by direct combustion. The water is evaporated to dryness, and the residue mixed with cupric oxide and burnt as in the elementary analysis of an organic compound. The resultant gas is collected over mercury, and the proportion of carbon dioxide and nitrogen determined by gasometric analysis. The process is as follows:—The amount of the water required for analysis will depend upon its quality. One litre will be sufficient if less than 0·1 part of ammonia in 100,000 parts of water has been found; if more than 0·1, but less than 0·5, half a litre will suffice; if more than 0·5, and less than 1·0, take a quarter of a litre. Of sewage, 100 c.c. or less will be sufficient. The measured quantity of

the water is placed in a large flask and 15 c.c. of a saturated solution of washed sulphurous acid added, and if the quantity does not exceed 250 c.c., the mixture is boiled for a few seconds to expel the carbon dioxide present. The water is then transferred little by little to a hemispherical glass dish 10 centimetres in diameter. During the evaporation the dish should be supported in a copper basin provided with a projecting flange and resting on the water bath, and over it a glass shade about 12 inches high is placed. The steam condenses in the inside of the shade and flows down the copper dish into the space between the two dishes. The excess of water flows out by a small lip on the edge of the copper dish. The destruction of the nitrates and nitrites by the sulphur dioxide may be greatly accelerated by the addition to the first dishful of water of two or three drops of ferric chloride solution, prepared by dissolving the solid substance in water. If the water is free from carbonates it will be necessary also to add 1 or 2 c.c. of a solution of sodium bisulphite in order to combine with the sulphuric acid formed, which if free would decompose the organic matter on concentration. If the water in the glass dish or flask ceases at any time during the process of the evaporation to smell of sulphur dioxide, more of the solution should be added. Should the water contain much nitric acid it may be necessary to digest the residue with a dilute solution of sulphur dioxide, and again evaporate to dryness to completely eliminate the inorganic nitrogen.

For the combustion of the residue, introduce a small quantity of cupric oxide in fine powder into the dish, and mix it thoroughly with the residue. A carefully cleaned combustion tube, which should be about 40 centimetres in length and 1 centimetre in internal diameter, is filled to about 3 centimetres with pure copper oxide, and the whole of the mixture in the glass dish is then placed in the tube, the dish being rinsed with small portions of pure cupric oxide in fine powder, and the rinse placed in the tube. Copper oxide is then added until the tube is a little more than half filled, and a cylinder of metallic copper, about 8 centimetres in length, made by wrapping fine copper gauze round a piece of thick copper wire, is afterwards inserted, and 2 centimetres of granular copper oxide added in order to oxidize any carbon monoxide which might be formed on burning. The end of the tube is softened in the flame of the blowpipe, and drawn out to form a tube about 100 millimetres long and 4 millimetres in diameter. This tube is bent at right angles, and the edges fused in the flame. It is then placed in the combustion furnace, and the tube attached to the Sprengel pump. When all is arranged the forepart of the tube containing the metallic copper and unmixed copper oxide is heated, and the Sprengel pump [see PNEUMATICS] set to work. If all has been carefully regulated the exhaustion will be complete in about ten minutes, when the mercury will fall with a sharp clicking sound. The action of the pump is then arrested, and the rest of the tube is gradually heated to redness; in about an hour the combustion will terminate, the pump is again set in operation, and the gases are transferred to the tube. These gases consist of carbon dioxide, nitrogen, nitrogen dioxide, and sometimes, if the combustion has been conducted too rapidly, sulphur dioxide and carbon monoxide. Their measurement and analysis are then made in the apparatus devised by Frankland for the separation of gases incidental to water analysis. As the accuracy of this method of combustion depends upon the perfection of the vacuum obtained by the Sprengel pump, and is liable to be affected to some slight degree by nitrogen retained in the copper oxide, absorption of ammonia, &c., during evaporation, &c., it is advisable to perform several blank determinations to ascertain the accumulated effects of these errors. This is done by evaporating to dryness, in the manner already described, a litre of pure distilled water, with the usual quantities of sulphurous acid and ferric chloride solutions, together with about 0·1 gramme of recently ignited sodium chloride; the residue is transferred to the tube and burnt, the gases being analyzed; the amounts of carbon and nitrogen found are to be deducted from the quantities obtained in the subsequent analysis of water residues. The corrections may amount to ·0003 gramme of carbon, and ·00005 of nitrogen per litre of water. The determination of the organic carbon and nitrogen in water is of considerable importance in determining the degree of organic contamination which it has experienced. Good drinking water should only contain about 0·2 part of carbon and 0·02 part of nitrogen per 100,000 parts of water. Sewage generally contains about 4 parts carbon and 2 parts nitrogen. The ratio of carbon to nitrogen is of great importance; the lower the ratio the more injurious is the organic matter. The ratio in water supplied for domestic purposes may vary from 5 to 12; sewage varies from 1 to 3; impure river water, from 3 to 5.

Determination of total soluble matter.—Ignite and weigh a platinum dish, which is then placed on the water-bath, and filled with the water to be examined, previously measured in a 250 c.c. flask. As evaporation takes place add more liquid from the flask; when empty rinse the vessel with a little distilled water, and pour the washings into the dish. On complete evaporation, heat the residue to 100° C. for an hour, or until the weight is constant. The increase in the weight of the dish gives the amount of soluble matter contained in one-fourth litre of water. *The estimation of the nitrates and nitrites* may be effected in the residue obtained from the above determination, by the action of precipitated copper and zinc. *The amount of chlorine* in water may be determined by standard silver nitrate and potassium chromate solutions. 1·1972 gramme of pure dry silver nitrate is dissolved in distilled water, and diluted to one litre; 1 c.c. of this solution is equal to 0·25 milligramme of chlorine. The potassium chromate solution requires to be strong and neutral. 50 c.c. of the water to be tested are placed in a porcelain basin, and coloured with two drops of the potassium chromate solution, and the silver solution is then added drop by drop until the permanent red colour of the silver chromate appears. If 50 c.c. have been measured, double the number of c.c. of the silver solution employed will give the amount of chlorine in parts per 100,000.

Very pure waters contain comparatively small quantities of chlorine—generally less than 1 part in 100,000. When contaminated with sewage the quantity is largely increased. In estimating the purity of drinking water from the amount of chlorine it contains, the nature of the strata through which it percolates must be taken into account. Spring water in the vicinity of the sea often contains considerable amounts of chlorine, especially if the district is sandy, the water at the same time being perfectly free from sewage contamination. The terms *hard* and *soft* waters express the action of soap upon the water. In hard water the presence of lime and magnesia salts decomposes the soap or stearate of soda, forming insoluble stearates of lime and magnesia, which then form the scum which accumulates on the surface of hard water after treatment with soap. Before therefore a hard water can produce a lather useful for detergent purposes, a sufficient amount of soap must be incorporated to convert all the lime and magnesia salts present into stearates. The *soap-destroying power of the water* is therefore an important element in determining its value for economic use. The *hardness* or soap-destroying power of the water is measured by employing upon a definite volume of the water a solution of soap of known strength, until a permanent and detergent lather is obtained. The strong soap solution is prepared by pounding in a mortar, in small quantities at a time, three parts of lead plaster and one part of dry potassium carbonate. When thoroughly mixed a small quantity of methylated spirit is added, and titurated until a creamy mixture is obtained. After standing for several hours the clear solution is filtered, and the residue is again treated with fresh quantities of methylated spirit until it is exhausted. If the solution remains clear on standing, its strength may be determined by the employment of a standard solution of calcium chloride. This solution is prepared by weighing out into a porcelain dish ·2 gramme of finely powdered marble, and covering the dish with a large watch-glass, dissolving the marble in dilute hydrochloric acid. The basin is heated on a water-bath, and when the expulsion of the carbon dioxide is complete, the under surface of the covering glass is rinsed into the basin, and the liquid evaporated to dryness. A small quantity of water is again added and evaporated to ensure the total removal of the excess of the hydrochloric acid. The residue is then dissolved

in water and diluted to 1000 c.c. The strong soap solution is diluted by taking 50 c.c. of the standard calcium chloride solution, and placing the same in a bottle of 250 c.c. capacity furnished with a stopper. The soap solution is then added drop by drop from a burette to the water in the bottle, and after each addition the bottle is well shaken. When a uniform lather is obtained which remains permanent for three or four minutes, the process is finished. The amount of soap solution used is read off on the burette, and the soap solution is then diluted with a mixture of two volumes of methylated spirit and one volume of water, until about 12 c.c. of the diluted mixture are equivalent to 50 c.c. of the standard calcium chloride solution. After standing for 24 hours it is filtered if necessary, and its strength again determined, and diluted further with the mixture of alcohol and water, until 14·25 c.c. exactly are required to produce a permanent lather with 50 c.c. of the standard calcium chloride solution.

HARDNESS OF WATER.

A	B	A	B	A	B	A	B
0·7	·00	4·6	5·43	8·5	11·05	12·4	17·06
·8	·16	·7	·57	·6	·20	·5	·22
·9	·32	·8	·71	·7	·35	·6	·38
1·0	·48	·9	·86	·8	·50	·7	·54
·1	·63	5·0	6·00	·9	·65	·8	·70
·2	·79	·1	·14	9·0	·80	·9	·86
·3	·95	·2	·29	·1	·95	13·0	18·02
·4	1.11	·3	·43	·2	12·11	·1	·17
·5	·27	·4	·57	·3	·26	·2	·33
·6	·43	·5	·71	·4	·41	·3	·49
·7	·56	·6	·86	·5	·56	·4	·65
·8	·69	·7	7·00	·6	·71	·5	·81
·9	·82	·8	·14	·7	·86	·6	·97
2·0	·95	·9	·29	·8	13·01	·7	19·13
·1	2·08	6·0	·43	·9	·16	·8	·29
·2	·21	·1	·57	10·0	·31	·9	·44
·3	·34	·2	·71	·1	·46	14·0	·60
·4	·47	·3	·86	·2	·61	·1	·76
·5	·60	·4	8·00	·3	·76	·2	·92
·6	·73	·5	·14	·4	·91	·3	20·08
·7	·86	·6	·29	·5	14·06	·4	·24
·8	·99	·7	·43	·6	·21	·5	·40
·9	3·12	·8	·57	·7	·37	·6	·56
3·0	·25	·9	·71	·8	·52	·7	·71
·1	·38	7·0	·86	·9	·68	·8	·87
·2	·51	·1	9·00	11·0	·84	·9	21·03
·3	·64	·2	·14	·1	15·00	15·0	·19
·4	·77	·3	·29	·2	·16	·1	·35
·5	·90	·4	·43	·3	·32	·2	·51
·6	4·03	·5	·57	·4	·48	·3	·68
·7	·16	·6	·71	·5	·63	·4	·85
·8	·29	·7	·86	·6	·79	·5	22·02
·9	·43	·8	10·00	·7	·95	·6	·18
4·0	·57	·9	·15	·8	16·11	·7	·35
·1	·71	8·0	·30	·9	·27	·8	·52
·2	·86	·1	·45	12·0	·43	·9	·69
·3	5·00	·2	·60	·1	·59	16·0	·86
·4	·14	·3	·75	·2	·75		
·5	·29	·4	·90	·3	·90		

In order to determine the hardness of the water, 50 c.c. are placed in a 250 c.c. bottle. The contents are then vigorously shaken, and the air sucked out of the bottle by means of a glass tube, by which the carbon dioxide liberated on agitation is expelled. A graduated burette is then filled with the soap solution, and 1 c.c. added at a time to the water, which after each addition is vigorously shaken. When froth commences to form, the soap solution is added in smaller quantities until a uniform and permanent lather is obtained. If more than 16 c.c. of the soap solution is required, the process must be repeated on a less quantity of water; 25 c.c., or less if the water is very hard, are placed in the bottle, and distilled water is added to make up the volume to 50 c.c., and the soap solution is added in small quantities at a time until the lather becomes permanent. The volume in cubic centimetres of soap solution used is multiplied by the number expressing the fraction of 50 c.c. taken; for instance, if 25 c.c. have been taken, multiply by 2; if 10, multiply by 5. The annexed table gives the weight of calcium carbonate in 100,000 parts of water corresponding to the number of c.c. required for 50 c.c. of the water. Column A gives the volume of soap solution; column B gives corresponding amount of calcium carbonate per 100,000 parts.

Water rich in magnesian salts gives a lather of a peculiar curdy appearance. Sometimes by boiling water the hardness is reduced; such water contains magnesium and calcium carbonates dissolved in free carbonic acid. In boiling the water the free carbonic acid is expelled, and the carbonates are precipitated, but no diminution of the hardness will take place unless it exceeds three parts in 100,000, as the carbonates are dissolved to that extent by water free from carbonic acid. When the hardness is not reduced by boiling, it is due to calcium and magnesium sulphates or chlorides, and such water is permanently hard. In analyzing water the distinction between *temporary* and *permanent* hardness should be determined. This may be ascertained by taking 50 c.c. of the water in a flask, the mouth of which is closed by a bulb having a short tube entering the flask; on evaporation the steam condenses in the tube and the water returns to the flask. After half an hour's slow ebullition the lamp is removed, and when the water has slightly cooled it is filtered, and its volume again made up to 50 c.c. The number of c.c. of soap solution required to determine its hardness shows the permanent hardness, and this subtracted from that of the unboiled water gives the temporary hardness. Sometimes the hardness of the water is partly due to free hydrochloric or sulphuric acids; therefore to determine its soap-destroying power, its reaction, acid or alkaline, should be previously ascertained. The hardness of water is of considerable importance in estimating its value for manufacturing purposes. The hard deposit in steam boilers usually consists of sulphate of lime and carbonates of calcium and magnesium, frequently mixed with co-precipitated organic matter.

In order to detect lead and copper in water, evaporate a litre of water to about 50 c.c., and filter it into a glass cylinder used for the determination of the ammonia; add two or three drops of acetic acid and 2 c.c. of a freshly prepared and saturated solution of sulphuretted hydrogen. Should a brown colouration take place fill a second cylinder with distilled water and acidulate with two or three drops of acetic acid, mix with 2 c.c. of the sulphuretted hydrogen solution, and add a standard solution of lead containing one-sixteenth milligramme per c.c., obtained by dissolving 0·1831 gramme of crystallized lead acetate in a litre of distilled water, until the colouration is the same in both cylinders. Copper may be accurately estimated by means of a solution of potassium ferrocyanide. The reddish-brown tint produced is then compared with that formed under similar circumstances in distilled water containing a known quantity of copper. Iron may be determined by a similar process. The value of a sample of water for domestic supply may be stated to consist in the estimation of the amounts of ammonia, of organic carbon and nitrogen, of nitrogen as nitrates and nitrites, of chlorine, of total soluble and suspended matter, of the hardness, and of the presence or absence of lead. Frequently the nature of the organic matter in solution has to be determined. For the estimation of silica a litre of the water should be evaporated to dryness in a platinum dish, after acidulation with a few drops of hydrochloric acid. The saline residue is thoroughly dried, moistened with hydrochloric acid, and diluted with hot water. The separated silica is then filtered off. For the estimation of the iron two drops of nitric acid are added to the filtrate from the silica, boiled, and a slight excess of ammonia added; the precipitate is allowed to settle, and the liquid filtered. The precipitate is redissolved in the smallest quantity of hydrochloric acid, and ammonia again added. The precipitate is then transferred to the filter, washed with hot water, dried, and the ferric oxide weighed. To estimate the lime, excess of ammonium oxalate is added to the filtrate from the preceding estimation, the precipitated calcium oxalate filtered, washed, and dried, and then ignited strongly and weighed as caustic lime. To estimate the magnesia the filtrate from the calcium oxalate is concentrated, sodium phos-

phate and ammonia are then added, and the magnesium ammonium phosphate treated in the usual manner. To estimate the sulphuric acid a litre of water is acidulated with a few drops of hydrochloric acid, and concentrated to 80 or 100 c.c., and an excess of barium chloride solution added. The precipitated barium sulphate is then filtered off and weighed.

To estimate phosphoric acid.—Frequently samples of water which largely contain lime and magnesia salts are found to possess estimable amounts of phosphoric acid. This may be determined by acidifying a litre of the water with nitric acid, and concentrating to 50 c.c.; a solution of molybdic acid is then added, prepared by dissolving 10 grammes of powdered ammonium molybdate in 40 c.c. of dilute ammonia, specific gravity 0·96, and mixing the solution with 160 c.c. of dilute nitric acid, 120 cubic centimetres of strong acid to 40 cubic centimetres of water; after standing for twenty-four hours, the yellow precipitate is filtered and washed, the precipitate treated with ammonia on the filter, and magnesia mixture added to precipitate the dissolved phosphoric acid. After standing a few hours the magnesium ammonium phosphate is filtered, and treated in the usual manner.

Estimation of sodium and potassium.—Add a few drops of barium chloride solution to a litre of the water to precipitate the sulphuric acid, and then boil with pure milk of lime to throw down the magnesia, iron, and phosphoric acid. Filter, and concentrate the filtrate, adding ammonia, ammonium carbonate, and a few drops of ammonium oxalate. Filter again, and evaporate the filtrate to dryness, and ignite to expel the ammoniacal salts. The residue is then treated with a small quantity of water, filtered and acidified with hydrochloric acid, and evaporated to dryness in a weighed platinum dish. The alkalies may then be separated by platinum tetrachloride, or their proportion may be ascertained by dilute standard silver solution and potassium chromate.

Pure rain water, when thoroughly aerated, contains about 25 c.c. of gases per litre, made up of nitrogen 15·9 c.c., oxygen 8·5 c.c., carbon dioxide 0·6 c.c. = 25·0 c.c, the ratio of the oxygen to the nitrogen being as ·1 : 1·87. When the water is contaminated with putrescent organic substances the amount of oxygen rapidly diminishes, being taken up from the water in oxidizing the carbon, hydrogen, and nitrogen contained in the organic matter. The determination of the ratio of the oxygen to the nitrogen in the contained gases generally indicates whether such putrefactive changes are in active operation in the water. One of the simplest methods for expelling the gases contained in the water is that of Reichardts, and the accurate analysis of the gas by the employment of liquid reagents is then a simple operation.

Analysis of Guano.—Guano, which is the excrement of sea birds, is always more or less affected by exposure to the weather. It contains ammonia in combination with uric, oxalic, carbonic, and phosphoric acids, phosphates and sulphates of lime, magnesia and alkalies, and in addition, more or less organic matter, water, sand, &c. Guano, besides varying greatly in its composition, is frequently very largely adulterated. Its value as a fertilizing agent depends chiefly upon the amount of ammonia and phosphoric acid which it contains. The sample to be analyzed should be carefully mixed, and about 50 grammes taken and placed in a stoppered bottle, from which the various portions used in the analysis are to be taken. To determine the moisture about 5 or 6 grammes are weighed out and placed in a tube, immersed in an oil-bath heated to 120° C., and connected by a rubber tube through the stopper to a flask; a slow current of dry air is drawn through the tube, and it is repeatedly weighed until the weight is constant. The flask contains 5 c.c. of normal acid, diluted with water, to absorb the ammonia, which readily volatilizes with the steam when guano is heated; the quantity of residual acid may be determined with litmus and a diluted soda solution in the ordinary manner. The loss in the weight of the tube, less the amount of ammonia retained in the flask, gives the quantity of moisture.

Determination of fixed inorganic matter.—About four-fifths of the dried guano is transferred from the tube to a platinum dish, carefully weighed. The tube is then carefully corked, the remaining portion of the dried guano being reserved for the estimation of the nitrogen. The portion in the dish is then slowly ignited, when the ash should be nearly white. If it is adulterated with sand or clay it will be of a reddish colour. The amount of ash in the higher classes of guanos does not exceed 15 per cent. The loss of weight gives the organic matter, together with the ammonia and combined water.

To determine the insoluble matter, sand, &c., the weighed portion of the ash should be diluted with hydrochloric acid; if the substance effervesces strongly the guano is probably adulterated with calcium carbonate. Heat on the water-bath for some time, and add water, then filter into a 300 c.c. flask; wash and dry the residue, and weigh.

To determine the phosphoric acid, lime, magnesia, sulphuric acid, and alkalies, make up the filtrate to the containing mark with distilled water and shake the flask. To estimate the phosphoric acid, lime, and magnesia, take 100 c.c. of the solution, and transfer to a ½ litre flask, add excess of ammonia, and then acetic acid to acidify solution. Dilute the liquid to the mark, and shake the contents in the flask; mark this solution *a*.

The phosphoric acid may be determined by using a standard solution of uranium. When a solution of acetate or nitrate of uranium is added to a solution of phosphoric acid, containing ammoniacal salts and free acetic acid, a precipitate of the double uranium—ammonium phosphate is produced, of a light greenish-yellow colour. This precipitate is insoluble in water and in acetic acid; it is, however, dissolved by the stronger acids. A solution of the acetate or nitrate of uranium gives a reddish-brown colour with potassium ferrocyanide. So long as any phosphoric acid is in solution this colour is not produced. These re-actions form an accurate volumetric method for the estimation of phosphoric acid. To prepare the standard solution of uranium about 35 grammes of well crystallized uranium nitrate are dissolved in 900 c.c. of water. The solution must be standardized by mixing with sodium acetate and a solution of pure sodium phosphate of known strength. 100 grammes of sodium acetate are dissolved in 900 c.c. of water, and diluted with strong acetic acid to 1 litre. Dissolve 10·085 grammes of pure and non-efflorescent crystals of sodium phosphate, previously dried by pressure between filter paper, in a litre of water. Then transfer 50 c.c. of the sodium phosphate solution, equivalent to 0·1 gramme P_2O_5, to a beaker, and add 5 c.c. of the sodium acetate solution, heating the mixture on the water bath up to 80° C.; then withdraw it, and quickly add 10 or 12 c.c. of the uranium solution, constantly stirring at the same time. The uranium solution is now to be added cautiously in quantities of 0·5 c.c. at a time, the mixture being tested after each addition. For this purpose a few drops of the turbid (but otherwise colourless) solution are placed on a porcelain slab, and a small drop of potassium ferrocyanide solution added. If there is the least excess of uranium salt present, a reddish-brown colour will appear. If this tint does not at once appear continue the addition of the uranium solution until it just appears. Replace the beaker on the water-bath, and in a minute or two again transfer a few drops to the slab, and test again with the ferrocyanide. If the colouration is distinctly apparent the process is completed.

The solution of the uranium salt is now diluted until 20 c.c. exactly are required for the 50 c.c. of sodium phosphate solution; 20 c.c. are therefore equivalent to 0·1 gramme of P_2O_5, or 1 c.c. = 5 milligrammes P_2O_5. Several trials, however, are necessary after the dilution has been made, to determine the exact strength of the solution. In order to determine the phosphoric acid contained in the solution of the guano by this process, take 50 c.c. of the acetic acid solution marked *a* of the phosphate and place in a beaker, heat on a water-bath, and proceed as described, and repeat the determination on a second portion of the liquid to verify the results. To determine the lime take 100 c.c. of the solution *a*, and place in a beaker, heat on a water bath, and add excess of ammonium oxalate; the calcium oxalate is then filtered off after standing, and weighed as carbonate, or it may be treated with sulphuric acid, and titrated with potassium permanganate. To estimate the magnesia, the filtrate from the lime precipitate is mixed with ammonia and sodium

phosphate, and the magnesium-ammonium phosphate is then weighed as pyrophosphate. The determination of sulphuric acid and alkalies may be made by transferring the remainder 200 c.c. of the filtrate used for the determination of the phosphoric acid, lime, magnesia, sulphuric acid, &c., to a beaker; heat, add barium chloride, and any barium sulphate that may form is filtered off. Milk of lime or bartya water is then added to the filtrate, which is boiled and filtered, and the excess of alkaline earth is precipitated with ammonia and ammonium carbonate; then filter, evaporate to dryness, and ignite, to expel the ammoniacal salts. The residue is then treated with a small quantity of water, filtered again, and the filtrate evaporated to dryness in a weighed platinum dish. The proportion of the alkalies in the washed chlorides may then be determined by a dilute standard solution of nitrate and potassium chromate.

To determine the nitrogen existing as ammonia, take from 1 to 5 grammes of the guano, according to its presumed richness in ammonia, as determined in the amount evolved in drying. This is weighed out into a retort and boiled with magnesia for some time; the ammonia is gradually expelled and collected in a flask containing a known quantity of standard sulphuric or hydrochloric acid diluted with water. The quantity of the residual free acid is then to be estimated by standard soda and litmus solution. Caustic soda or lime cannot be used in expelling the ammonia, since these substances would convert a portion of the nitrogenous organic matter into ammonia.

The nitrogen existing as azotised organic matter, uric acid, &c., may be estimated by ignition with soda-lime. Several organic substances containing nitrogen, not in the form of nitroxides, when heated with a caustic alkali give up the whole of their nitrogen in the form of ammonia. This reaction constitutes the principle of a convenient method for estimating the amount of organic nitrogen existing in manures. To carry out this method of analysis the following preparations are required:—A combustion tube about 40 centimetres long and from 10 to 12 millimetres in internal diameter; soda-lime, prepared by heating a sufficient quantity of the coarsely powdered substance in a porcelain basin just before it is required for use and allowed to cool; oxalic acid, well dried in the water-bath so as to expel all its water of crystallization; asbestos, prepared by igniting a small quantity in the gas flame immediately before using; a bulbed U-tube, fitted with an india-rubber stopper and bent tube. On the end of the bent tube is a cork which fits tightly into the combustion tube.

The process is then as follows:—Introduce a layer, about 3 centimetres in length, of the dried oxalic acid mixed with a small quantity of soda-lime, into the posterior end of the tube, and afterwards an equal bulk of soda-lime. Then weigh out from the tube the remainder of the dried guano, obtained in the determination of the moisture, into a dry porcelain mortar, and mix it with soda-lime. The mixture should then without loss of time be placed in the tube, as it is apt to part with a small quantity of ammonia, and rinse out the mortar with a fresh portion of soda-lime. The substance should be mixed with a sufficient amount of soda-lime to occupy about 20 centimetres of the length of the tube. Fill up the tube to within 5 centimetres of its length with soda-lime, and insert a loosely fitting plug of recently ignited asbestos. Fit in the cork of the U-tube, and transfer 10 c.c. of standard acid to the U-tube with sufficient water to half fill the bulbs. Gently tap the combustion tube so as to make a passage for the evolved gases. The combustion tube is then placed in the furnace and gradually heated along its entire length, commencing at the end nearest the U-tube. The heat should be sufficient to cause a steady evolution of gas; towards the end it may be increased to break up any cyanides which may have been formed. The extreme end of the tube where the oxalic acid is situated should not be heated until the evolution of the gas has almost ceased. When the combustion is ended and the evolution of gas has entirely ceased, then cautiously heat the oxalic acid; a rapid current of carbon dioxide is evolved which drives out all the ammonia remaining in the tube. When the evolution of the gas has nearly finished, remove the U-tube, add a few drops of litmus solution, and dilute caustic soda solution from a burette, until the free acid is nearly neutralized. The liquid is then poured into a beaker; wash out the bulbs, and complete the addition of the soda solution. The strength of the soda solution should be such that about 3 c.c. are equivalent to 1 c.c. of normal acid. If the nitrogen is to be determined by weight, rinse the bulbs into a beaker, and pour the solution through a moistened filter. Evaporate the filtrate to dryness with excess of platinum tetrachloride, and transfer the washed double salt to a weighed platinum crucible by the aid of a glass rod and a stream of alcohol from a small wash bottle, and dry it slowly; heat the crucible to bright redness and weigh the residual platinum—197·2 parts of platinum are equivalent to 28 parts of nitrogen. The amount of the nitrogen cannot be calculated from the weight of the double salt, since it is liable to contain considerable quantities of compounds of platinum with organic bases. These bases, however, contain the same proportion of nitrogen and platinum as the ammonium-platinum chloride. By determining the amount of platinum left on ignition the proportion of the nitrogen is readily calculated. Deduct the amount of nitrogen corresponding to the ammonia found in the determination of nitrogen existing as ammonia; the difference then shows the quantity of organic nitrogen.

Superphosphates.—In the majority of naturally occurring phosphates the phosphoric acid contained is not readily soluble in water, and is therefore not in the form in which it can be readily assimilated by plants. In the process of manufacturing manure a portion of the phosphoric acid is converted into the soluble modification by treating the phosphorite, bone dust, spent bone-black, &c., with sulphuric acid. By this treatment the insoluble tricalcium phosphate ($Ca_3P_2O_8$) is converted into the soluble monocalcium phosphate ($CaH_4P_2O_8$), calcium sulphate being simultaneously produced. The pasty mass which runs from the vessel in which the mixture of phosphate and acid is made becomes dry on standing, partly from evaporation and partly from the assimilation of the water. To increase the fertilizing power of the material various substances are added, such as liquid or dried blood, either before or after treatment with the acid. Superphosphate consists therefore essentially of monocalcium phosphate ($CaH_4P_2O_8$), or soluble phosphate, mixed with tricalcium phosphate ($Ca_3P_2O_8$), insoluble phosphate, calcium sulphate, oxides of iron, alumina, magnesia, and alkalies, and more or less organic matter and moisture. In the analysis to be made, sample the mixture carefully, and place a portion in a stoppered bottle, from which the quantities used in the several estimations are to be taken. To determine the water: dry a weighed portion of the sample at 170° C. in the air-bath until its weight is constant. The loss gives the quantity of moisture and water existing in combination with the calcium sulphate. Weigh 10 grammes of the undried superphosphate into a mortar and titurate with a small quantity of cold water; allow the suspended matter to settle for a few minutes, and filter the liquid into a 500 c.c. flask. The extraction should be repeated with cold water several times, and the residue finally washed with hot water, transferring the washings to the filter. Dilute the filtrate to the mark on the 500 c.c. bottle and shake the liquid. Weigh the insoluble portion. The filtrate is then examined for the estimation of the ferric phosphate and soluble calcium phosphate by placing 200 c.c. of the liquid in a platinum dish and evaporating, adding an excess of sodium carbonate and a little nitre so soon as the whole of the liquid is placed in the dish. Evaporate, and when dry ignite gently; mix with a little water, and rinse the contents of the dish into a beaker; add excess of hydrochloric acid, and heat until the liquid is clear. Then mix with excess of ammonia, acidulate with acetic acid, and filter off and weigh the ferric phosphate, placing the filtrate in a 250 c.c. flask. Dilute to the mark and shake the contents of the flask. Successive portions of 50 c.c. are then withdrawn to determine the phosphoric acid by uranium solution. Transfer 100 c.c. of the liquid to a beaker, and determine the lime and magnesia as already directed in analysis of manure. To estimate the organic matter and alkalies: evaporate 100 c.c. of the liquid in a platinum dish, adding milk of lime until

the liquid is clearly alkaline. The residue is then dried at 180° C. and weighed. Ignite the mass and again weigh, the difference being the amount of organic matter. Then boil the weighed residue with lime water, and afterwards with pure water; filter, and add barium chloride to precipitate the sulphuric acid; afterwards mix with ammonia, ammonium carbonate and oxalate. Then filter, evaporate to dryness with hydrochloric acid, igniting the residue; treat with water, filter, and weigh the alkaline chlorides. To determine the sulphuric acid, heat 100 c.c. of the liquid in a beaker, acidulate with a few drops of hydrochloric acid, and precipitate with barium chloride.

For the determination of the insoluble portion, the carbon may be estimated by igniting gently in a platinum dish a weighed portion of the sample; the loss of weight gives the amount of organic matter and carbon. The determination of sand, clay, &c., is made by boiling the ignited portion repeatedly with dilute hydrochloric acid and filtering into a quarter-litre flask, washing with hot water. The insoluble residue consists of sand and clay. Dilute the filtrate to the mark, and shake the contents. To determine the phosphoric acid, iron, lime, and magnesia: transfer 100 c.c. of the above solution to a beaker, and carry out the process described in the estimation of the ferric phosphate and soluble calcium phosphate. The determination of sulphuric acid is by taking 100 c.c. and employing barium chloride as already described. The determination of total nitrogen is by taking from 1 to 2 grammes of the original sample, and ignition with soda-lime, as already described in the process by ignition with soda-lime in determining nitrogen as azotised organic matter in guano. Superphosphates are frequently mixed with ammoniacal salts.

To tabulate the results of the analysis of the sample, the data obtained should be expressed somewhat as follows:—

Soluble constituents, . { Phosphoric acid. Lime. Magnesia. Ferric oxide.

Insoluble constituents, { Phosphoric acid. Lime. Magnesia. Ferric oxide. Alumina.

Total calcium sulphate, ...
" organic matter and charcoal containing ( ) per cent. of nitrogen, equal to ( ) per cent of ammonia, ...
" sand and clay, ...
" moisture, ...

In using the Baumé hydrometer for the determination of the gravity of liquids (see Hydrometers, page 355) the following tables will be found valuable:—

TABLE FOR LIQUIDS LIGHTER THAN WATER.

Degrees, Baumé.	Specific Gravity.	Degrees, Baumé.	Specific Gravity.	Degrees, Baumé.	Specific Gravity.
10	1·000	27	0·896	44	0·811
11	0·993	28	0·890	45	0·807
12	0·986	29	0·885	46	0·802
13	0·980	30	0·880	47	0·798
14	0·973	31	0·874	48	0·794
15	0·967	32	0·869	49	0·789
16	0·960	33	0·864	50	0·785
17	0·954	34	0·859	51	0·781
18	0·948	35	0·854	52	0·777
19	0·942	36	0·849	53	0·773
20	0·936	37	0·844	54	0·768
21	0·930	38	0·839	55	0·764
22	0·924	39	0·834	56	0·760
23	0·918	40	0·830	57	0·757
24	0·913	41	0·825	58	0·753
25	0·907	42	0·820	59	0·749
26	0·901	43	0·816	60	0·745

TABLE FOR LIQUIDS HEAVIER THAN WATER.

Degrees, Baumé.	Specific Gravity.	Degrees, Baumé.	Specific Gravity.	Degrees, Baumé.	Specific Gravity.
0	1·000	26	1·206	52	1·520
1	1·007	27	1·216	53	1·535
2	1·013	28	1·226	54	1·551
3	1·020	29	1·236	55	1·567
4	1·027	30	1·246	56	1·583
5	1·034	31	1·256	57	1·600
6	1·041	32	1·267	58	1·617
7	1·048	33	1·277	59	1·634
8	1·056	34	1·288	60	1·652
9	1·063	35	1·299	61	1·670
10	1·070	36	1·310	62	1·689
11	1·078	37	1·322	63	1·708
12	1·086	38	1·333	64	1·727
13	1·094	39	1·345	65	1·747
14	1·101	40	1·357	66	1·767
15	1·109	41	1·369	67	1·788
16	1·118	42	1·382	68	1·809
17	1·126	43	1·395	69	1·831
18	1·134	44	1·407	70	1·854
19	1·143	45	1·421	71	1·877
20	1·152	46	1·434	72	1·900
21	1·160	47	1·448	73	1·924
22	1·169	48	1·462	74	1·949
23	1·178	49	1·476	75	1·974
24	1·188	50	1·490	76	2·000
25	1·197	51	1·505		

When Twaddell's hygrometer is employed, the degrees are converted into specific gravity (water being 1000) by multiplying the number of degrees by 5, and adding 1000 to the product. To reduce specific gravity (water being 1000) to Twaddell degrees, deduct 1000 and divide the remainder by 5.

HISTORY OF GREAT BRITAIN AND IRELAND.

CHAPTER XIV.

THE FOUR GEORGES, WILLIAM IV. AND QUEEN VICTORIA.

Since the introduction into practical politics of the principle of Parliamentary control of legislation and administration, and the recognition of the deliberative voice of the two chambers as decisive upon the policy to be pursued by the executive, history has been revolutionized. It no longer derives its supreme interest from the personality of princes, but receives it from the principles of Parliament. Therein is the will of the people declared, and real sovereignty is shifted from that of the personality of monarch or ministry to that of public opinion. Of course a change such as this, radical though it is, manifests itself outwardly only in a gradual manner. Old forms continue, but a new spirit animates them. This spirit rules, and the chief interest in modern, but especially in recent history, arises from the growth and progress of rational representation in national government.

In a high state of civilization individual energy seeks outlet and free field—vigour and originality press to the front; and when a body, representative of the entire mass of the nation, comes under their influence, the men who possess (or sometimes only profess) such capacity become the guides, leaders, and rulers of states. Modern history is a record of progress from individual imperialism to ministerial responsibility, broad-based upon the people's will. The growth of constitutional government is the main fact in the varied and marvellous historic record of the nineteenth century. In interest it eclipses the character and conduct of kings and statesmen, the objects of wars and treaties, the intrigues of parties, and the most signal incidents of ceremonial state. National progress implies the imposing of the utmost possible personal responsibility on all the parties holding in trust the national interests—the electorate, who chose the members of the Commons; the representatives, who express and enforce the opinions and rights of the people; the chief of the cabinet,

who, though officially appointed by the Crown, is really designated by Parliament; and all the functionaries whom he selects to carry out in detail the public business of the nation. The recent history of Great Britain and Ireland is no longer a bead-roll of biographies of sovereigns and statesmen, but a record of the opinions and political acts of the people and the Parliament.

During Anne's illness George was in Holland, the Scottish Jacobites were kept in check, the fleet was put in charge of a stanch Whig, and the fidelity of the army was secured. The seven great officers of state and eighteen justices carried on the public business till George reached England, 18th September. He was crowned 20th October, 1714. Lord Townshend, Earl Stanhope, and Sir Robert Walpole formed the new ministry. Bolingbroke and Ormond sought safety in France, and were attainted. Oxford, being impeached, was imprisoned in the Tower, but was cheered on his way to it. On the assembling of Parliament, 21st March, 1715, a committee was appointed to inquire into the negotiations resulting in the peace of Utrecht, and Marlborough was restored to his former position as commander of the army. The Jacobite reaction, for the public proclamation of which Dr. Sacheverell had suffered in 1709 and been promoted, took the shape of riotous assemblies. William III. was burnt in effigy. Oak leaves were worn at Oxford in commemoration of the restoration of Charles, 29th May. So great was the unpopularity of the king and men's sympathy with the Jacobites that the Riot Act—forbidding the unauthorized assembly of more than twelve persons in any public place, and permitting the dispersion of mobs, after due warning, by armed force—was passed 20th July. Louis XIV. died 1st September, and his successor was a minor. The Duke of Orleans, as regent, was anxious to keep on fair (outward) terms with England, and therefore did not countenance the movements of the Pretender, who had on 29th August issued a manifesto in assertion of his claims. The Earl of Mar proclaimed James III. at Braemar 30th September, while in the north of England the Earl of Derwentwater and Mr. Forster rose in his favour. On the same day, 13th November, 1715, the English rising was crushed at Preston by Generals Wills and Carpenter, and the Scottish one by the Duke of Argyle on Sheriffmuir, near Dunblane. In the former 1400 surrendered; the nobles and gentry were sent to London, and marched like criminals through the streets. Twenty-six were hanged, drawn, and quartered, and the commoners were sold as slaves to the North American planters. James landed at Peterhead with a suite of six persons, 22nd December, 1715, and made a public entry into Dundee on 6th January, 1716. He subsequently retreated to Perth, and on 4th February, accompanied by Mar, returned to France. Though Admiral Byng had defeated a Spanish fleet off Cape Passaro in Sicily in 1718, yet in 1719, under the Duke of Ormond, an expedition left Spain to invade Britain. Only two frigates reached Scotland. The 300 men they carried, joined by a few Highlanders, occupied the Pass of Glensheil, but were dislodged and dispersed. In 1724 the office of secretary for Scotland was abolished, owing to the occurrence of a malt-tax riot in Glasgow.

England had fortified herself against the Pretender by the Quadruple Alliance, but Ireland was found troublesome, and a statute was passed empowering the English Parliament to legislate for the pacification of that country. Then there came the terrible crash of the South Sea scheme. The South Sea Company, originated by Harley, earl of Oxford, in 1711, to purchase £10,000,000 of the national debt at 6 per cent. interest, had secured a monopoly of the trade in the South seas. One ship, in 1717, made one voyage to the South American continent in the service of the company, which had become, like the contemporary Mississippi scheme, an enormous joint-stock financial corporation. It arose with dazzling splendour, which was hollow, and it collapsed in irretrievable ruin. Walpole intervened. Prosecutions were instituted, several directors were fined and imprisoned, families were reduced to beggary, and many individuals felt the pressure of poverty for life. Public credit being restored, Walpole became prime minister. Carteret was made Lord-lieutenant of Ireland, Jacobitism revived, Bishop Atterbury was banished, and Pulteney joined the Opposition. The Spaniards, who had threatened Gibraltar in 1720, in 1727 attacked and besieged it with 20,000 men: but this was bravely resisted. In the general peace of that year, 31st May, it still remained a British possession. On 11th June, 1727, George I. died at Osnabrück, and George II., his only son by his wife Sophia Dorothea—who had been immured in the Castle of Ahlden, in Hanover, from 1694 till her death there in 1726, on a charge of an immoral intrigue with Count Königsmark—became his successor.

George II. was born at Hanover on 30th October, 1683, and married on 22nd August, 1705, Wilhelmine Caroline of Anspach. He was created Duke of Cambridge in 1706, and distinguished himself at Oudenarde in 1708. On his father's accession he was granted, as Prince of Wales, an income of £100,000 per annum. Having engaged in political intrigues, he was, in 1717, dismissed from court, and his children detained in the care and custody of the king. George II. retained Walpole as prime minister, although Sir Spencer Compton was proposed as his rival. The publication of parliamentary reports was declared a breach of the privileges of the legislative chambers. Little fear was entertained of Jacobite invasion. England, France, and Holland concluded the peace of Seville with Spain in 1729, and in the treaty of Vienna Britain guaranteed the Pragmatic Sanction. Some relief was granted to dissenters during Walpole's administration. Prison reform was commenced, and in 1731 all proceedings in courts of justice were ordered to take place in English—not, as heretofore, in Law Latin. Standing armies were denounced, and Walpole's Excise Bill was defeated. The war of the Polish Succession broke out, but England remained neutral. Endeavours were made to repeal the Septennial Act, and in 1735 the affairs of Europe subsided into peace. Wesleyanism had meanwhile arisen, and the excessive use of spirituous liquors led to the passing of the Gin Act, and gin riots occasioned great trouble. While George II. visited his German dominions the queen was made regent, and during her rule there occurred that riot in Scotland to which, in "The Heart of Midlothian," Sir Walter Scott has given more than historic vitality. Two Fife smugglers had robbed the custom-house of Pittenweem, and on being tried were sentenced to death. By the aid of the one, Wilson, the other, Robertson, escaped, and when, 14th April, 1736, Wilson was hanged, the mob of Edinburgh attacked the city guard. Porteous ordered the guard to fire, when several were killed. For this he was tried and sentenced, but respited. The mob dragged him from the chimney of his cell, and hung him from a barber's pole. It was proposed to deprive Edinburgh of its charter; the provost was deposed, and the city fined £2000. George returned in 1737. His son, the Prince of Wales, married in April. He was disliked by both parents, and quarrels arose. These were fomented by intriguers. Queen Caroline died 20th November, 1737, and on 4th June, 1738, George (Augustus), grandson of the king, was born. A party formed about the prince. Faction plunged Britain into war with Spain for some alleged interference with the freedom of commerce in 1739. In 1740 the Austrian Succession War occurred. It "did veritably rage for eight years at a terrific rate," but, as Carlyle says, "of Dettingen and Fontenoy, where is the living Englishman that has the least notion or seeks for any? They are capable of being skipped in one's inquiries into the wonders of this England and this world," though leaving a large mnemonic of national debt to its taxpayers.

Seizing this opportunity, an army, under General Saxe, gathered at Dunkirk, in 1744, for the invasion of England, in favour of Prince Charles Edward. It was conquered by a storm. By the French brig *Doutelle* Prince Charles was landed at Moidart, 25th July, 1745. He marched thence to Perth and Edinburgh. Gardiner's dragoons performed "the Canter of Coltbridge," the prince proclaimed James VIII. at "the mercat cross," took up his quarters at Holyrood, and on 21st September defeated Sir John Cope at Prestonpans. Having entered England Charles took Carlisle, and marching towards London had reached Derby. Then he began a retreat. In a skirmish at Clifton Moor Cumberland's horse were repulsed. At Falkirk Hawley's forces fled; but at Culloden Moor—the last pitched battle that took

place on British soil, 16th April, 1746—the deathblow to the Jacobite rebellion was given. Charles—the theme of many a romance—reduced to miserable straits, escaped to France, and died at Rome in 1788. The Earl of Kilmarnock and Lords Balmerino and Lovat were beheaded, and Flora Macdonald endured imprisonment for a year.

The Duke of Cumberland, victor at Culloden, was defeated at Lauffeld, 1747, and the peace of Aix-la-Chapelle closed the war, leaving Maria Theresa in possession. The Prince of Wales died in 1751, while Clive was creating the Indian Empire. In 1752 "new style" was adopted, Pelham died, and the Duke of Newcastle succeeded him as prime minister. The Seven Years' War broke out 1756–63 (see HISTORY, pp. 1065–66), and Newcastle resigned. Pitt rose into power, and despite the monarch's dislike—carried even to dismissal—maintained his place, kept up the national enthusiasm, conducted the brilliant warlike operations which paralyzed France, drove her fleets from the sea, and her armies from India and America. George II. died 25th October, 1760.

George III., the first member of the Hanoverian dynasty whose birth took place in the land he ruled, was born in Norfolk House, London, 4th June, 1738, ascended the throne, which he occupied nearly sixty years, 25th October, 1760, and died 29th January, 1820, aged eighty-two. Though the Whigs were in place the Tories accepted this home-born scion of the Brunswick stock. In his speech at the opening of Parliament he said, "I glory in the name of Briton." Pitt, in 1761, discovered the family compact between Charles III. of Spain and Louis XV. to unite in warfare against England, and at once suggested war and the seizure of Spain's treasure-ships. He was overruled and resigned. Bute, who as "a Tory, a favourite, and a Scotchman," was unpopular, found it impossible to avoid adopting the policy he had opposed, and war was declared against Spain, 4th January, 1762. It was soon humiliated, and both France and Spain might have been speedily crushed had not Bute, eager for peace at any price, consented to the treaty of Paris, 10th February, 1763, which also, so far as England, France, and Spain were concerned, brought the Seven Years' War to a close. Though Fox succeeded in securing the approval of this peace, he could not save the Bute ministry, and Mr. Grenville, a professed Whig, was called to office. He governed on Tory lines. Then came the times of the "Liberty" Wilkes prosecutions (1763–74), the "Letters" of Junius (1769–72), the trial of Woodfall, involving the freedom of the press; and the impolitic proposal to tax the American colonies raised those hostile feelings which culminated in the American War of Independence, 1774–84 (see HISTORY, Chap. XV., p. 975). France declared in favour of the United States in 1778, Spain in 1779, Holland in 1781, thus giving England a fourfold set of foes to fight; while during Clive's second administration (1765-67), in the war with Hyder Ali (1767–69), during the administration of Warren Hastings, first governor-general of India—including the war with the Rohillas (1774) and the Mahratta War (1778-82)—and in the contests with France and Holland in the East, till the passing of Pitt's India Bill (1784), British arms were pretty fully engaged.

Concurrently with these stirring interests ran the industrial developments of steam machinery—Watt's first improvements (1765), his renewed patent (1775), the application of steam-power to cotton spinning (1785), the invention of Hargreaves' spinning Jenny and Arkwright's spinning frame (1767), Crompton's mule jenny (1775) and Dr. Cartwright's power-loom (1785), the extension of the turnpike road system (1763–74), the introduction of mail coaches, and the active construction of canals (1762). John Howard began a movement for legislative action in the amelioration of prisons, and an agitation for the abolition of the slave trade was commenced by Granville Sharp, in 1777. In 1772 Lord Mansfield gave the decision embodied by Cowper in the lines—

> "Slaves cannot breathe in England: if their lungs
> Receive our air, that moment they are free;
> They touch our country and their shackles fall."

The society for the suppression of the slave trade was founded in 1787; the House of Commons agreed to its abolition in 1792; a Bill for that purpose received the royal assent 25th May, 1807; slavery ceased on 1st August, 1834; and emancipation took place four years thereafter. Parliamentary reform was proposed by the Earl of Chatham (1770); and successive motions to effect it were introduced by Pitt (1783 and 1785), by Flood (1790), and by Grey (1792). The two last Pitt opposed as inopportune. Parliamentary reporting, which had been prohibited in 1738, was permitted in 1771. Though the fresh religious movement of the Wesleys and Whitefield widened, toleration did not receive much favour. Yet in the church itself, initiated by the Rev. Charles Simeon, there arose an Evangelical section shortly after 1779. The Act to restrain Popery, passed in 1770, was repealed in 1778. In 1780 the Lord George Gordon anti-popery riots occurred, and the ringleader, charged with high treason, was, through the eloquence of Erskine, acquitted. Ireland was disaffected. In 1778 the Irish requested that the privileges granted to the colonies should be extended to them. When the demand was not acceded to they resolved that they would buy no British goods till greater freedom was given to Ireland. On the plea that the country was inadequately defended, they formed themselves into companies of volunteers. In 1780 Grattan's motion "that the king's most excellent Majesty, the Lords, and the Commons of Ireland are the only power competent to make laws to bind Ireland" passed. Pitt proposed to remodel the Irish government, but was defeated. Then the Catholic Whiteboys and the Protestant Peep-o'-day boys began recrimination, reprisals, and outrage, till at the outbreak of the French Revolution this discontent found a vent. Wolf Tone, in 1791, originated the United Irishmen. It was suppressed, met in secret, and fell into a French plot, in alliance with which General Hoche invaded Ireland, 1796. A great Dutch fleet intended for Ireland was defeated at Camperdown, 1797. Though government in 1795 had endowed Maynooth, dissatisfaction continued. Lord Fitzgerald was captured and died; Wexford was besieged; Vinegar Hill was fought. Emmet and O'Connor were taken, and sent to Fort George in Scotland; Tone was seized, tried, sentenced, and committed suicide. Then Pitt put an end to the Irish parliament by the Legislative Union, 1st January, 1801.

The king's obstinate refusal to yield to the dismemberment of the empire by granting independence to America led John Dunning (afterwards Lord Ashburton, to propose (1780) in the Commons the resolution—"That the power of the crown has increased, is increasing, and ought to be diminished"—which is so often quoted and parodied. Various ministries were formed and defeated. The nation was now anxious to be at peace, and at length the United States were declared independent, 3rd September, 1783, and on 2nd June, 1785, George III. received Mr. John Adams, their first ambassador to his court, with pleasing urbanity. The French Revolution—the chief incidents of which are related in HISTORY, Chap. XVI. pp. 1065–70—was regarded with dislike and fear. Pitt began that war which was signalized by so many naval victories, so many defeats on land, and ultimately merged into the ante-Napoleonic struggle, of which an epitome is given in HISTORY, Chap. XVII. pp. 1161–65.

Fox declared sympathy with the Revolution, Burke published his "Reflections" upon it. Sir James Mackintosh replied to him in his "Vindiciæ Gallicæ," 1791. Paine issued "The Rights of Man" (1791). The Association of the Friends of the People was formed by one party, the Association in Support of the Constitution by the other. The trial of Horne Tooke, Hardy, Thelwell, and others took place. Peace and reform were exchanged for war and reaction. The *Habeas Corpus* Act was, for the first time since 1745, suspended during eight years. Bread riots, Acts against treasonable attempts and seditious meetings, the suspension of cash payments by the Bank of England, Pitt's Bank Restriction Act, mutinies at Spithead and the Nore, show that disorganization was threatening. Pitt proposed a Catholic Relief Bill, the king opposed it. Pitt resigned and Addington (Lord Sidmouth) took the reins, while the sovereign, under the excitement, fell a second time into that state of insanity which had led in 1788 to the preparation of the (then unnecessary) Regency Bill. Pitt was besought to form a ministry, for disaster and disgrace were daily damaging the empire. Lord

Melville was censured by the Commons, dismissed from the Privy Council, and his impeachment proposed. The coalition Pitt had formed against Napoleon was shattered at Austerlitz, and he died 23rd January, 1806. The ministry of "all the talents" under Grenville took office, 10th February, but Fox, who was its leading spirit, died 13th September. The Portland ministry succeeded, 31st March, 1807. George Canning and Lord Castlereagh quarrelled as to the conduct of the war, fought a duel, Portland resigned, and died a month afterwards, and Spencer Percival became premier, 6th December, 1809. Once more the king became insane. A Regency Act was passed 1811, and the Prince Regent retained the Cabinet. But Percival was assassinated by John Bellingham, and Lord Liverpool undertook the administration, 16th June, 1812, which he held till February, 1827. George III., blind and insane, died at Windsor, 29th January, 1820.

While these political changes were going on, some social occurrences requiring notice took place. In 1811 a conspiracy against the use of machinery in manufactures resulted in riots at Nottingham, and developed into insurrection, under the name of Luddism, in 1812. The educational systems of Lancaster and Bell were actively promulgated —1808, and onwards—with beneficial results, and by the discovery of new materials, the adoption of improved processes, the invention of new machinery, and especially the employment of steam as a labour-saving agent, manufactures developed in a remarkable manner, and quite transformed the interests of Britain, by making it necessary to seek markets in every quarter of the world for the merchandise which, in unexampled quantity and quality, she had ready for disposal. While commerce augmented the national wealth, agriculture was stimulated by good prices to increase its products for the food of the people. Wastes were reclaimed and inclosed, drainage was improved, better implements were made, better methods were devised, and grazing was raised to high effectiveness. Art was encouraged, science spread, travel and adventure were undertaken, literature was popularized, colonization extended, and finance was studied and practised on better principles than formerly. While the nation was controlling the political destinies of Europe, and its armies were proving their prowess on every field, Britain was building up a staying power which would enable it to secede from the merely dynastic contentions of the Continent, and to become the arbiter in every contest affecting the real interests of man.

By the settlement of 1815 George III. had been made the first king of Hanover; when therefore the Prince Regent, George (Augustus Frederick) IV., succeeded his father it was with the title of King of England and Hanover. His life had been dissolute and extravagant, and in public affairs he had given little cause for trust. He had married, for state purposes alone, Caroline of Brunswick. A daughter was born of this marriage, 1796. She in 1816 became the wife of Leopold, afterwards king of the Belgians; but she died in 1817. George—devoted to other feminine charmers—had separated from his wife, who had been charged with immorality in 1806, and had retired to the Continent. On his accession her name was omitted from the church-service, and her allowance from the civil list ceased; she returned, a bill was introduced to degrade and divorce her, but abandoned. At the coronation, 19th July, 1821, she demanded admission to Westminster Abbey, was refused, and died 7th August. The Peterloo massacre, 16th August, 1819, and the proposal of the "Six Acts" by Sidmouth and Castlereagh had excited intense feeling. The Cato Street conspiracy to murder the ministry was discovered, and five of its members were beheaded. A riot at Huddersfield and a skirmish at Bonnymuir indicated the progress of Radicalism. The amendment of the criminal code made progress, and the proposal for popular education was presented in the first Parliament. Rather than concur in the bill against the Queen, George Canning resigned office, and had been offered the governor-generalship of India. He was labouring, prior to his going, in favour of Catholic claims, when, during the king's absence in Scotland, Lord Castlereagh committed suicide, 1822, and he was called to be foreign secretary, Lord Sidmouth was replaced in the home office by Robert Peel, who had been Irish secretary. Huskisson passed his Reciprocity Duties Bill, 1823, and in 1824–25 saved commerce from wreck. Canning saved Portugal at a critical juncture, 1826. In 1827, Canning, on Lord Liverpool's death, became premier, concluded the treaty of London, and died, 8th August. "The blood-red blossom of war" sprang from that treaty under Viscount Goderich, and the Turco-Egyptian embroilment closed at Navarino, 1827. Goderich was replaced by Wellington, 1828. The Catholic Emancipation Bill was passed, and received the royal signature, 13th April, 1829. But the Catholic association and the rent its members paid were not thereby stayed. O'Connell still found use and need for both. Peel's Metropolitan Police Bill also passed in 1829, and on 26th June, 1830, "the first gentleman of Europe" died. Thackeray in his "Four Georges" (1861) has not hesitated "to draw his frailties" as well as those of his predecessors "from their dread abode."

His sailor-brother, the Duke of Clarence, as William IV., "reigned in his stead." The Duke of Wellington was prime minister, and he knew that a crisis was imminent in Europe. He declared against parliamentary reform, but on a motion for the revision of the Civil List he was defeated, and Earl Grey installed. His cry was "Peace, retrenchment, and reform." A long severe struggle ensued. In the end Lord Grey—though defeated and dismissed, and riot and insurrection swayed to and fro, so that civil war seemed inevitable—triumphed, 7th June, 1832. The strife which had begun in 1787 for the abolition of slavery was renewed, and was successful, 30th August, 1833. A new Poor Law Act was passed 1834, municipal reform was accomplished, and an endeavour was made by a Tithe Commutation Act (1837) to pacify Ireland, now under the influence of Daniel O'Connell's strong mind and vigorous oratory. The king, who had married in 1818 Princess Adelaide—neither of whose two daughters survived infancy—died at Windsor, 20th June, 1837.

Alexandrina Victoria, niece of William IV., the sixth sovereign of the Hanoverian dynasty, then became queen of Great Britain and Ireland, with all their dependencies. She was born at Kensington Palace, 24th May, 1819. She entered on her august duties under Lord Melbourne, and was crowned in Westminster Abbey, 28th June, 1838. On his defeat in 1838 Sir Robert Peel was called to office; but on the question of dismissing the ladies of the bedchamber the queen recalled Melbourne. In 1839 she was betrothed, and in 1840 married to Prince Albert. Her private life has been such as to secure singular respect, and her public life has been one of diligent and intelligent anxiety for the constitutional progress of the nation, and of ready deference to the properly expressed will of the people. Not only in her domestic joy have her people rejoiced, they have been sympathetic in her bereavements, and felt a partnership of heart in her sorrows. When her excellent mother died (1861), and, before the same year had closed, the world was once more darkened grievously to her by the death of him who had worn "the snow-white livery of a simple life unsoiled" —Albert the Good—her people mourned with her. Similarly, when in 1871 the Prince of Wales lay nigh unto death, the nation's heart thrilled with thanksgiving at his recovery. The demise of Princess Alice, 1878, evoked deep sorrow, and the favourite of the nation, Leopold, when he died, was mourned with a strong sense of loss. In her more recent griefs similar sympathy has been accorded. Alike when young life nestled in the palace, or marriage-mirth prevailed, or desolation and distress enshrouded it, Queen Victoria has always had the affection, respect, and sympathy of her subjects. Their devotion culminated in a heart-hymn of love when her jubilee year came round.

On her accession Lord Melbourne was in power, and continued so till, in 1841, he was succeeded by Sir Robert Peel. After carrying the Repeal of the Corn Laws, 1846, having been defeated in his Irish measures, Peel resigned, and Lord John Russell was called to power. He achieved the repeal of the Navigation Laws and the Removal of Jewish Disabilities, but was defeated on a Militia Bill to provide defence in case of foreign aggression, March, 1852. Lord Derby was called to office. His ministry broke down on the Disraeli Budget in December, and a coalition cabinet, under

the Earl of Aberdeen, was formed. The country "drifted" into the Crimean War, during which, on a motion for an inquiry into the state of the army before Sebastopol being carried, Lord Aberdeen resigned. Then Lord Palmerston rose to the premiership. He conducted the Russian War with vigour, and engaged in the Chinese War. This was disapproved. He appealed to the country, 1857, and was supported by a large majority. On the Conspiracy Bill—in favour of Napoleon III.—his administration fell, and the Earl of Derby was again chosen to rule in the cabinet. He passed the India Bill, 1858. In 1859, however, he was defeated on the Reform Bill proposed by Mr. Disraeli, and, after appealing to the results of a general election unsuccessfully, required to replace the reins of government in the hands of Lord Palmerston. These he held till his death, 18th October, 1865. Earl Russell succeeded him as prime minister; but Mr. Gladstone's Franchise Bill being defeated, June, 1866, he was replaced by Earl Derby, who requested Mr. Disraeli to "give the franchise with no niggard hand." Household suffrage was proposed, accepted, and passed, 1867.

In 1868 Lord Derby, owing to failing health, commended Mr. Disraeli as his successor. He took office, but was defeated on the question of the disestablishment of the Irish Church, and Mr. Gladstone undertook the formation of an administration. He disestablished and disendowed the Irish Church, passed an Irish Land Bill, threw open the Civil Service to competition, and abolished purchase in the army. Under him the English and Scottish Education Acts were passed, but in 1873 his government was defeated on the Irish University Education Bill, and Mr. Disraeli returned to power in 1874. This he retained for six years, taking to himself a peerage, as Lord Beaconsfield, on his return from the Berlin conference, whence he brought "peace with honour." Owing to the conduct of the wars in Afghanistan and South Africa the tide of public feeling turned, and when the general election in 1880 came, he was in a minority. Mr. Gladstone was again called to place, and during his tenure of power passed the Representation of the People Act and a Redistribution Bill, which raised the electorate to 5,000,000. In the autumn of 1885 Parliament was dissolved. Lord Salisbury held office for a short time, but in a division on small allotments his government was defeated, and Mr. Gladstone was again called to form a ministry. His Home Rule and Irish Land Bills disrupted his party, a defeat by a majority of thirty led to immediate resignation, and the election which ensued indicated a large preponderance of Conservative opinion. Lord Salisbury again became prime minister, and during the next six years (1886-1892) several important Acts were passed. Amongst these may be mentioned the Free Education Act, whereby school fees were abolished in most of the elementary schools in Scotland, while in England a grant of 10s. per scholar in average attendance was made, and in Ireland similar provision was granted; the English and Scottish Local Government Bills, and Irish Land Purchase Bills were passed. In 1892 the dissolution and general election took place, when it was found that Lord Salisbury's party was in a minority, and Mr. Gladstone was again called to office.

Since the Revolution political parties fight their battles on the platform and at the election-booths—decerning which is victor not by swords but votes. Representation was confined to the propertied and intelligent classes by the Reform Bill of 1832. But when commercial depression came in 1835, and failing harvests caused food to be dear, the masses thought that if they had power in the country they could mend matters, and in 1838 instituted Chartism. "The people's Charter" demanded (1) the franchise for every male twenty-one years of age, of sound mind, and unconvicted of crime; (2) equal electoral districts; (3) vote by ballot; (4) annual parliaments; (5) no property qualifications for members of the Commons, and (6) payment of members for their services. These were called "the six points." Immense meetings and great torchlight processions in 1838 kept the autumn-time astir. These were declared to be illegal and repressed; many of the most active leaders were arrested, and in 1839 a National Convention was held in Birmingham. The military were called out, public meetings were forbidden, and a petition signed by 1,280,000 presented to the Commons. For being concerned in a Chartist Riot at Newport in 1839, Frost, Williams, and Jones were tried, and condemned to death, but they were ultimately banished. Disturbed relations continued, and in 1842 several riots occurred. Joseph Sturge, deprecating this strife, instituted the Complete Suffrage Union as a "moral-force Chartism," while Fergus O'Connor and others maintained the Universal Suffrage Association, claiming the right to exercise "physical force" if their claims were withheld. Robert Owen's advocacy of a new moral world—now known as Secularism—Richard Cobden's agitation for the repeal of the Corn Laws, and Daniel O'Connell's movement for the repeal of the Union, complicated political and imbittered social relations. They all, however, tended to educate the people—excited them to read, discuss, think, and write. This investigation of political problems led many to feel the need of instruction, and great endeavours were made to acquire educational advantages at evening schools, mechanics' institutes, &c. A sense of ignorance and the pressure of want made men think that the laws were not sufficiently heedful of their case, and that they could only escape from the evils they endured by having the power of law-making in their own hands. In the ferment of 1848 great fears were entertained—riot was resolved on; but it was met and mastered. It began to dawn on men's minds that he who was excluded from the rights could not be expected to fulfil the duties of citizenship, because he had neither the feelings nor the interests of a citizen. Several Bills for the extension and regulation of the franchise were passed in the belief that the choice of representatives, if made on public rather than on party grounds, might secure good government at home and confidence in the steady influence of Britain abroad. Parties have recently been disintegrated. The old traditional views of electioneering have not yet so fallen into disuse as to bring the common-sense patriotism of Britain into a combinate body bent on securing the best men that can be got to take their place in the great council of the nation. Organizations for influencing elections have recently assumed new forms—somewhat affecting, however, the free use of the suffrage and the independence of candidates.

Prior to 1840, when Parliament voted any increase of expenditure, the ingenuity of our finance ministers was tasked to discover a tax that could be justly imposed and readily collected. This fact tended greatly to the restriction of expenditure. But the long peace we had enjoyed, the progress of science, the marvellous development of invention, the application of both science and invention to the arts of life and the industries by which men live, the rapid way in which a network of railways was woven over the face of the country, the improvements introduced into agriculture and manufactures by division of labour and aggregation into centres, the growth of colonization, the discovery of gold, the increase of material wealth, and the greater exercise of thrift—all combined to induce a great change in our fiscal policy and commercial measures. The revolution in financial policy, inaugurated by Sir Robert Peel in 1842, was absolutely necessary. Between 1837-40 the budgets failed to realize the anticipated income. This seemed to imply an exhaustion of the resources available for taxation. The new Poor Law, the Chartist agitation, the slackness of trade, the dearth of provisions, the congestion of population—unrelieved by emigration—the activity of the Anti-Corn-Law League, the introduction of the penny postage system, and a heavy increase in the naval and military expenditure, each contributed to the difficulty of providing for the national expenditure. In 1840 the chancellor tried a general increase in the usual duties and customs without success. He next resolved to see if by a sweeping reduction of these the revenue could be stimulated. This was—though since found to be a good principle—regarded then as the height of absurdity, and Lord Melbourne, who had been Prime Minister from 1835, was replaced by Sir Robert Peel in 1841. The estimated income was £48,350,000, and the expenditure, £50,819,000, leaving a deficiency to be made up by the income tax of £2,469,000. Peel had matured a bold financial policy, and made "an earnest appeal to the possessors of property" to aid him in his endeavour to "repair the evil" of constantly increasing deficits, which required to be met by such means as the appropriation of savings bank deposits, the issue of exchequer bonds, and other forms of

getting loans by trickery, and then proposed an income tax of £2 18*s.* 4*d.* per cent. on all incomes exceeding £150 in England and Scotland—not Ireland. It was carried after strong and long-continued opposition. Its power as a financial engine has since been recognized and exercised by chancellors of either party.

This tax was renewed in 1845 and in 1848. Then a financial reform association was inaugurated in 1849 to insist on the revision of our systems of finance and administration. During the ten years 1853–63 the tax was laid on incomes of £100 per annum, and extended to Ireland. The rate fluctuated considerably, and was less in amount on incomes ranging between £100 and £150. The decade 1863–73 maintained the area of taxation, but granted exemptions on £60, £80, and £120. Since 1876 exemption of £120 on all incomes under £400 and of all incomes under £150 has prevailed, and the tax which, under Pitt, in 1797, was levied on £100,000,000, and in 1842 on £250,000,000, has recently been calculated as leviable upon £650,000,000—the rate being varied as need arises. While taxable wealth has been increasing, the national expenditure has been increasing with more than equal rapidity, the financial demands on the nation having risen to nearly £91,000,000. The total amount of the national debt exceeds £684,000,000—involving an annual charge of over £25,600,000. Many endeavours have been made by various financiers—*e.g.* Mr. Goulbourn in 1830 and 1844, and Mr. Goschen in 1888, by conversion of stock—to lessen the burden of the tax-payer on account of this debt. Great changes have been made in the customs duties—*i.e.* taxes on imports—since the adoption in 1846 of free-trade principles. The productiveness of the duty on alcohol has shown a decline, which has now reached a fall of £4,000,000. The consumption of tea has doubled since 1857; but customs and excise together show a decline in yield—amounting from 1874 to about £8,000,000. Every ministry is now more and more restricted in its means of securing revenue, and the re-adjustment of taxation forms a battle-ground between the free and the fair trader.

The free-trade struggle was a long and severe one. In 1828 the sliding scale of duties on corn imports was regarded as an almost perfect mode of self-acting adaptation. In 1834 an association was formed in London to secure the repeal of "the taxes on food;" but in 1839 the Anti-Corn-Law League constituted itself into a great organization for educating the people in the principles of political economy, and by dispersing a band of popular lecturers throughout the country convinced it of the policy of permitting trading intercourse among nations unimpeded by restrictive duties or legislation. Concessions were made in 1842 and 1844. But this stimulated a protectionist opposition, and led to the founding of the Agricultural Protection Society. The very general failure of the potato crop in 1845, the famine in Ireland in 1846, and the political activity of the League led to the repeal of the Corn Laws and the disruption of the Conservative party in 1846. Corn dealing has became a normal trade; but the cost of freight, the growth of population, improved means of buying, and higher taste in food-stuffs have prevented bread from falling quite as much as was hoped; while the prophesies of peace as likely to arise from the commercial brotherhood of nations have not been fulfilled. The fall in the rental of land consequent on the difficulty of competing culture has created a great amount of political discontent and agitation, and induced the re-advocacy of restrictions on imports. It is probable that the direction of capital to manufactures here and to agriculture elsewhere will ultimately tend to a re-adjustment of interests according to the principles of an enlightened political economy.

The commercial crisis of 1844–46 was exceedingly severe. It originated in the over-zeal with which railway development was pursued, and required, during these three years, an estimated expenditure of £185,000,000. This was far beyond what could be conveniently spared at the time, when famine required extensive purchases of food; a failure in cotton had raised its price 50 per cent., and both industry and capital were withdrawn from the manufacture of exportable goods, and engaged in the making of railways. A drain of gold began, and the crash of 1847 ensued. It is true that the demand for labour and the increased consumpt of food, &c., occasioned a large expenditure of money, and gave a considerable impulse to the revenue. But this money, which enabled the bank to enlarge credit drawn upon for the payment of labour, while it stimulated commercial activity in its transit, went, in consequence of bad harvests, in a large amount for commodities not procurable at home, and did not return to the bank. Credit was straitened, money could not be got to keep going at once the old manufactures of the country and these new and costly undertakings. Discount rose to 8 per cent. Hence immediate pressure, then panic, and ultimately heavy loss. Government was appealed to, the Bank Act was suspended, and £30,000,000 of liabilities were unmet by bankrupt traders. Of course the railways when completed made the profits of trade more rapid. The time of transit was shortened, the quantity of stock requiring to be kept on hand was lessened; this liberated capital, and large reductions took place in the cost of transit. Trade was stimulated, and the benefits of these costly and embarrassing undertakings are felt now. In these investments £830,000,000 of capital has been sunk; and there is realized from them a return of over £33,000,000 per annum, while upwards of 400,000 persons are employed in their management and working. In 1840 general railway legislation was introduced, and there have been a very large number of Acts of Parliament passed for the regulation of the important interests of the railway system.

While inland communication was developed with extraordinary energy, the mercantile marine service was also undergoing rapid extension. Since the *Sirius* and *Great Western* sailed in 1838 as pioneers of the transatlantic steamship trade, ocean voyagers have become numerous, important, and successful—not only as passenger ships and mail packets, but also as carriers of cargo and of freightage. Competing companies for steam-ship traffic have stimulated shipbuilding and immensely improved the carrying trade. The sailings and arrivals of ocean steamers considerably exceed a quarter of a million per annum. The substitution of iron for wood, and of steel for iron, is working great changes in the character of the vessels used for maritime commerce. The machinery employed in them, and the improved methods of combustion now found possible, greatly enhance speed, propelling force, and carrying power. Of the gross tonnage of the timber and composite steam vessels of the world, nearly one-third is ours; of iron, five-eighths; of steel, seven-ninths; while of the net total tonnage of the sailing vessels upwards of four-elevenths belong to Britain and her colonies. Of the war-fleets of the world possessed by the seven chief naval powers of Europe, ours, it is stated, is, in type, material, and number—if considered from a strictly practical point of view—one scarcely quite sufficient to secure both the invulnerability of our coasts and the safety of the vast commerce which is dependent on our maintaining the sovereignty of the sea. Some say that £100,000,000 would scarcely suffice to secure an irresistible navy and to fulfil the manifold responsibilities to commerce which we have undertaken in every region of the globe. Should this be even so, Britain will doubtlessly defend her commerce and adequately implement her responsibilities.

Commerce is Britain's characteristic, and her enterprise therein is unexampled. Liberty to trade in any locality is regarded as the absolute right of a Briton—although a license from the Crown is necessary as a permit to trade with any alien enemy of the State. By the Municipal Corporation Act, 1835, and several subsequent legislative measures, many restrictions on the manufacture and sale of lawful wares and merchandise have been abolished, and the repeal of the Navigation Act in 1849 removed many restrictions on commercial freedom. The importance of British commerce may be estimated by the amount of annual exports, about £290,000,000, and of the imports, about £390,000,000—although of course these amounts vary from year to year. It is not very easy to estimate the amount of the home trade and the results of the manufacture and distribution of the produce of our own soil and industries, mines, fisheries, &c., so far as these are consumed within the realm. The Board of Trade has been instituted in the interests of commerce, and has charge of

corn and mercantile returns, railways, harbours, fisheries, finance, shipping and seamen, patents, and bankruptcy. By the issue of a monthly *Journal*, it supplies information of importance to merchants, manufacturers, shippers, &c.—*e.g.* extracts from and translations of official documents of home, colonial, or foreign governments referring to customs tariffs, commercial treaties, fluctuations of trade, conditions of industries, &c. The returns of the Board of Trade are highly valuable as affording trustworthy information concerning the state of commerce.

Both our army and navy are essentially defensive organizations, and have never been manned for offensive warfare. The manner in which these forces have been employed in the Burmese Wars, 1824–26, 1852, and 1885-86; in the Afghan Wars, 1839–42, 1878-80; in the Chinese Wars, 1840, 1856, 1860; in the Sinde War, 1843; in the Sikh War, 1845–49; in the Crimean War, 1854–55; in the Indian Mutiny, 1857–58; in the Abyssinian War, 1867–68; in the Ashantee War, 1874; in the Zulu War, 1878–79; in the Egyptian War, 1882–88, and in several smaller and less significant engagements, has been related, in outline, in HISTORY, pp. 1259–60, and 1356-58.

War paralyzes industry and cripples commerce, and hence a strong peace-party may always be expected in trading communities. That all nations should unite in a "bond of brotherhood" has been ably argued as a theory, and some politicians have been supposed, by their strong denunciations of war, to be advocates of peace at any price. Notwithstanding the immense commercial interests of England—some say, just on account of these—the war establishment of Britain is large and expensive. The regular army consists of nearly 227,000 men, the reserve forces amount to about 73,000, the militia to upwards of 114,000, yeomanry 11,000, and volunteers 222,000. Its cost is not much less than £20,000,000. The commander-in-chief has charge of the entire *personnel* of the combatant forces—regular and irregular—and is responsible for their efficiency and discipline. The secretary for war, since 1854, is responsible to Parliament for the disposal and employment of these forces. For the navy we require nearly 50,000 officers and men engaged in the coastguard and fleet service, together with 21,000 reserves and 2000 volunteers. There are about 140 ships in commission, distributed over twelve stations. The ships in Her Majesty's service are classed as—(1) Line-of-battle, (2) cruisers, (3) gun vessels, (4) gun and torpedo boats: detailed particulars are regularly issued in *The Naval Annual*. During the last two centuries the government of the navy has remained much the same as Parliament, in 1688, planned it. Yet it has sustained the credit of the service through some of the most remarkable political, social, and scientific changes the world has seen. It is administered by a First Lord of the Admiralty, in the cabinet; four Naval Lords, a Civil Lord, and two secretaries. The annual estimates amount to about £14,000,000.

The social condition of the working-classes has during recent times been much ameliorated and brought under the influence of sanitary precautionary and self-protecting legislation. On the whole, it may be stated that the working people of Britain are better paid—taking into account not only the wages earned, but also the commodities (*i.e.* the comforts) capable of being received in exchange for them—and better safeguarded against injury and oppression than any other settled community and fully occupied country. The restraints imposed by law on the employment of labour and for the prohibition of the truck and tally system are mainly beneficial. The joint action of the industrial sections in trades unions and labour partnerships legally sanctioned is working for good. The facilities for and encouragements to thrift have been greatly extended. Technical skill, mechanical intelligence, and productive inventiveness have been promoted. The concurrent efficiency of machinery and labour has been enormously enhanced. Machinery is tending more and more to reduce the functions of the labourer to those of attention, guidance, and constancy of operation, and labour is developing towards ease, rapidity, and exactness of manipulative skill. The competitions of capitalists in all the permanent industries of life are better regulated. Yet while all these co-operating influences tend to lowering of price, good wages are on the average, pretty fairly maintained. Great improvements have lately been introduced by the utilization of what had hitherto been looked on as waste products, and extreme thrift of material has lessened loss and increased wealth. Industrial problems, the relations between capital and labour, the securing of constancy of work and wages, the settlement of differences between employers and employed by some safe and just form of arbitration, or a self-adjusting relation between profits and wages, have not yet been satisfactorily solved; but the idea of a warfare between capitalist and workman is being exchanged for one of a copartnery of the classes and the masses in industrial and commercial pursuits, and an endeavour is being made to realize the community of the interests of all the members of the commonwealth. The "History of Prices" has been traced. "Work and Wages" have been subjected to scientific scrutiny. "Progress and Poverty" have been discussed. Utilitarianism, socialism, organized labour—such as agricultural holdings, industrial partnerships, and co-operation make possible—and many other modes of improving the condition of the agricultural, artisan, factory, urban, and rural population, have been carefully considered. It is undesirable that the great mass of the nation should be kept merely on the hither-side of death, and wise effort is endeavouring to realize the true civilization of the country by improving all improvable citizens and dealing with the residuum of the wretched, the vicious, and the criminal in as kindly and effective a plan as may gradually minimize, if it cannot wholly get rid of it. Poor law and criminal legislation, vagrancy acts, and the organization of charity are working well to accomplish the latter, while education and technical training, thrift-schemes of many kinds, model dwellings, and numerous other methods of encouraging and aiding the recuperative energy of the honestly industrious, have in recent times been employed with good results in bringing comfort, hope, and aspiration into the lives of the working classes.

Brief as the summary of our recent history has necessarily been, it has shown remarkable progress in civilization. Literature, science, art, industry, commerce, with all the concomitant refinements and comforts they supply, have flourished, on the whole, through all the varied changes of time and circumstance, of which a brief record has been attempted in these pages. Those who seek a more extended history than we have given will not find it difficult to procure. There are many to be had—of varying extent and quality. Any of them being thoroughly studied will confirm the view of the national progress here given, that in honest reliance on prudent politics, wise morality, and sound religion, the future stability and civilization of the country are well assured, and that, as in the past so in the present—

> "Naught shall make us rue
> If England to itself do rest but true."

ENGLISH LITERATURE.—CHAPTER XVI.

SECTION I.—POETRY: CRABBE TO TENNYSON.

"POETRY," said Wordsworth, "is the breath and finer spirit of all knowledge"—knowledge, that is, of man and nature, thought and feeling, passion and incident, joy and sorrow, life and duty. Over the philosophic analysis of the nature of poetry few have been able to exercise the diviner's rod. When poetry came to a pause in England about 1770, and a prelusive silence fell upon the nation, prior to those symphonic bursts of natural song which greeted the ear in the closing years of the eighteenth century—expectation could scarcely have dreamed that such voices should arise as those of Cowper, Burns, and Crabbe. "Auld Robin Gray," "The Flowers of the Forest," "There's nae luck about the House," Carey's "Sally in our Alley," Miss Blamire's "Nabob," and other similar wayside flowers of verse, show the influence of Percy's "Reliques of Ancient Poetry" (1765). James Macpherson (1738–96) failed with his heroic poem "The Highlander" (1758), but made quite a conquest of the world by the strange pseudo-Celtic wind-harp songs of "Ossian," and lost its favour as quickly again by producing a version of Homer's "Iliad" in the same style. He died only a few months before Burns.

Robert Fergusson (1750–74) helped to carry on the bright nationality which Ramsay had maintained till Burns snatched up the Scottish lyre which had fallen from the hand of him whom he tenderly regarded as

> "My elder brother in misfortune,
> By far my elder brother in the Muses."

Fergusson's "Leith Races," "Cauler Water," "Braid Claith," and "Farmer's Ingle," if not so firm and terse, are softer and more polished than similar poems by the Bard of Coila. James Beattie, in "The Minstrel" (1771), exhibits how communion with nature quickens poetical genius. He imitates Spenser in the measure of his verse and in the harmony, simplicity, and variety of his composition, and almost foreshadows what the "Prelude" tells us of Wordsworth's training to

> "Feel through all this fleshly dress
> Bright shoots of everlastingness."

Erasmus Darwin (1731–1802), an original thinker, a fair versifier, and quite an adept in the logic of analogy, in his "Botanic Garden" (1791), "Zoonomia, or the Laws of Organic Life" (1794–96), "The Temple and Shrine of Nature" (1803), &c., endeavoured to induce men to study science by giving the theories of philosophers a poetic vesture.

George Crabbe—whom Horace Smith dubbed "a Pope in worsted stockings"—the poet of the daily life of the humble poor, was born at Aldborough, in Suffolk, in 1754; he studied medicine and attempted practice, but with little success. He composed "Inebriety" (1775), "The Candidate" (1779), and went to London to seek fame and fortune. They did not come to him so readily as he had thought they would, and he was reduced to extremity. In his distress he applied to Lords North, Shelburne, Thurlow, and others connected with Suffolk, but no heed was vouchsafed. As a last resource, he laid his case before Edmund Burke, who invited him to Beaconsfield and introduced him to several friends. By his aid Crabbe was enabled to take holy orders in 1781. He was made priest in 1782, and held several charges. The Duke of Rutland gave him the living of Trowbridge, Wilts, to which he added the incumbency of Croxton, near his castle of Belvoir. Burke, Johnson, and Sir Joshua Reynolds took a lively interest in the success of "The Library" (1783) and "The Newspaper" (1785). Upwards of twenty-four years elapsed before he produced "The Parish Register" (1807); "The Borough" appeared in 1810, "Tales in Verse" in 1812, and "Tales of the Hall" in 1819. The last-named and the unexpired copyright of his previous works were bought by Murray for £3000, and "Nature's sternest poet, but her best," as Byron called him, ceased to write poetry. He died in 1832. Crabbe's character-painting is close, minute, and subtle, but frequently descends to trivialities and vulgarities. His style is generally prosaic and commonplace, terse, but often disfigured by equivoques and bathos. He had no delicate æsthetic taste. The gems he gathers are set with less care and polish, and in ruder ornamentation, than they ought. His verses are not even what Dr. Johnson calls "mechanic echoes of the Mantuan song." They want the selectness, fitness, and melody of the Virgilian rhythm. But his matter is good and his manner powerful. His eye is keen to see, his pen pointed to express, and his mind pithy to impress; though the simplicity of his verse is often marred by the coarse and repulsive aspects of life he chooses for his theme—poachers, smugglers, and gipsy-thieves, passion-driven men and misled maidens, tyrannous landlords and oppressed tenants, and all the elements of semi-civilization. He is the pre-Raphaelite of commonplace.

William Blake (1757–1827) united a painter's eye to a poet's mind, and regarded as his business "not to gather gold, but to make glorious shapes expressing godlike sentiments." He gave his days to the graver and his nights to the muses. A grand suggestiveness distinguishes the productions alike of burin and pen. Deeply penetrated with the melody and splendour, beauty and passion of Elizabethan poetry, he wished to mirror forth to eyes and mind the lofty conceptions and imaginations nature excited in him. His ambition was to suffuse the arts of design with the harmony of music and the vitality of poetry. Flaxman and a friend named Matthews undertook the cost of an early edition of his poems in 1787. In 1789 he issued "Songs of Innocence." His "Songs of Experience" belong to 1794. In these volumes Blake gives deep truths expression in simple idyllic strains. He had a singular power of subduing the unseen by his far-gazing eye. His poems were phenomena seen in his imagination, and his pictures were the outward vesture his ideas wore. Things were the windows through which thoughts were seen, and in his verse he offers the power

> "To see a world in a grain of sand,
> And Heaven in a wild flower;
> Hold infinity in the palm of your hand,
> And eternity in an hour."

The wild mysteriousness of his later fancies, and the fact that poem and picture are with him one in their wholeness, must prevent him from being popular; but his sweet simplicity and marvellous metaphysical suggestiveness have influenced many of our modern singers—Browning, Clough, Morris, Rossetti, W. B. Scott, Arnold, Swinburne, and others. "Poor, sick in body, and beloved of the gods," Blake lived, painted, thought, and wrote, till—having finished as his last work a likeness of his wife—on 12th August, 1827, he passed through "death's door" into the presence of "The Ancient of Days."

"The vision and the faculty divine" have seldom been better employed than they have been by William Cowper in glorifying everyday experiences with the beauty of poetry. The strains of his saintly harp have given charm to the commonplace of human life, and shown that emotioned thought may be embued with attractions for the heart, even though it has been elicited only by the common round of the joys and sorrows felt in the ordinary course of existence. He is the poet of his "native nook of earth"—its scenes, its sentiments, its affections, interests, social customs, and religious aspirations. Cowper—born at Great Berkhamstead, Hertfordshire, 26th November, 1731—was delicate in health and nervous in temperament. He was but six years old when his mother died, and when put to school suffered from a bullying classfellow barbarities which embittered his whole existence. His eyesight being endangered, he was placed under an eminent oculist's care, and subsequently entered Westminster school—where Coleman, Churchill, Cumberland, Warren Hastings, (Chancellor) Thurlow, &c., were his schoolfellows. In his eighteenth year he was apprenticed to a solicitor, and about this time studied French and Italian, read the classics, and wrote in some of the essay periodicals. Shortly after taking chambers at the Temple, he became subject to fits of dejection. He and his cousin, Theodora Jane Cowper, had fallen in love, but "judicious considerations" prevented any match. He made little progress in law. After his father's sudden death, Cowper had conferred upon him an office in the House of Lords, but his timidity was such that he never entered upon his duties, and was so overwhelmed with fear that he attempted suicide. He was placed under medical treatment for a time, and ultimately became an inmate of the family of the Rev. Morley Unwin of Huntingdon, and when, on his death, 1767, Mrs. Unwin removed to Olney, Cowper went thither as a boarder. Here, having formed an intimacy with the Rev. John Newton, Cowper began his contributions to the "Olney Hymns." His mental malady occasionally affected him, but he was kindly tended by Mrs. Unwin, and many friends felt interest in his melancholy lot. Though he had versified a little, he had scarcely up till this time, when he was fifty years of age, dreamt of writing his name among the poets of Britain. He now, under pressure from friends, composed—between September, 1780, and February, 1781—"Table Talk," "Hope," "The Progress of Error," "Charity," "Expostulation," and in 1782 they were published in an octavo volume. Dr. Johnson and Benjamin Franklin relished these manly, vigorous, and original poems, and gradually they gained favour. At the suggestion of Lady Austin, widow of Sir Robert Austin, he commenced "The Task," was led to bethink himself of translating Homer, and wrote "The Diverting History of John Gilpin." In 1784 "The Task"—with its grave morality, majestic rhythm, pleasing descriptiveness, and its rich religious setting of the true wisdom of life—impressed the public by its poetic power. Then he put the result of

his Greek studies at Westminster and his classical reading in the Temple into the 40,000 lines of his simple, masterly, and powerful blank-verse translation of Homer, 1791. It is, as a whole, literal, admirable, and almost faultless. Three years afterwards he had a pension of £300 bestowed on him by the Crown. His mind fell under an eclipse again. He died—fearing that he was a "castaway" from Divine grace—25th April, 1800. He is the poet of personal religion, of social life, of the affections, and of nature. Alike in his humour and his pathos, he is simple and true. Of his minor poems, the lines on "His Mother's Picture," on "Mary Unwin," "Boadicea," and "The Loss of the Royal George" are gem-like in their pellucid purity, and "John Gilpin" glows with child-like good humour. Hayley's estimate on Cowper's monument in East Dereham is finely just:—

> "England, exulting in his spotless fame,
> Ranks with her dearest sons his favourite name;
> Sense, fancy, wit suffice not all to raise
> So clear a title to affection's praise;
> His highest honours to the heart belong;
> His virtues formed the magic of his song."

Cowper was upwards of twenty-eight when, on 25th January, 1759, Robert Burns, the Ayrshire peasant bard, was born at Alloway. Scotland regards with gladness "the happy miracle of that rare birth." His toilsome life began in early boyhood, when he required to give all the help he could on his father's small farm—doing, under the pressure of stern necessity, while ill-fed and growing fast, the work of a man. He stooped his shoulders bravely to the burden, and became, in consequence, subject to a nervous disorder which affected the action of his heart. A little schooling and some private teaching enabled him to become a diligent reader, and round the farmer's ingle the song, legend, and folk-lore of the district secured absorption in his mind. As a lad he attended fairs, dancing schools, masons' meetings, penny weddings, drinking bouts, and took part in debating societies. Amid the cheerless gloom of a hermit and the unceasing toil of a galley-slave, the bashful and awkward, though rather musical and hardship-nipped youth felt higher aspirings and the impulses of inborn power. In his fifteenth year, under a flush of emotion, his first love-song, "Handsome Nell," was composed. He yearned after more scholar-craft and some means of improving "the clouterly appearance" of his "ploughboy carcase," and for these purposes, after his father's removal to Lochlea, he attended Kirkoswald school "to learn mensuration, surveying, dialling," &c., engaged heartily in rustic sports and rural love-intrigues, got acquainted with smugglers and loose manners, and read a good many famous English books. He tried to get into business as a flax-dresser in Irvine, but found it a ruinous affair, and having besides been engaged in an amour, thought it best to return to the plough. On 13th February, 1784, William Burns, the poet's father, died at Lochlea, and was buried in Alloway Kirkyard—where over his remains Robert placed a simple tombstone, with a tenderly-toned verse inscription. Before this sad event, and just while Cowper was engaged in carrying out Lady Austin's "Task," Robert Burns began his Common-place Book, and described himself (in his twenty-fourth year) as "a man who had little art in making money, and still less in keeping it; but was, however, a man of some sense, a great deal of honesty, and unbounded good-will to every creature, rational or irrational." Burns and his brother Gilbert took a lease of Mossgiel farm, near Mauchline, as a joint concern for behoof of the family—each one having ordinary wages. Those of the poet were £7 per annum, and his expenses did not exceed this sum. At this time his health failed, he was brought under serious impressions, and he composed several paraphrases of the Psalms and other poems of a religious nature; at the same time also he "became known in the neighbourhood as a maker of rhymes," by the (private) issue in MS. of "The Two Herds, or The Holy Tulzie," "Holy Willie's Prayer," "The Holy Fair," "The Jolly Beggars," and a number of rhyming epistles and songs. The farm did not prosper, the poet's indiscretion led to a private marriage, a design to go to Jamaica as overseer on a plantation, and the gathering together of some of his "rhyming ware" for publication as a means of gaining funds to take him there. While hurrying to become a poet in print, and irritated at the ill-feeling of his wife's relatives, he engaged in a romantic episode of love with "Highland Mary" Campbell. On 31st July, 1786, his "Poems" were published in Kilmarnock. Men were dazzled and delighted. Dr. Blacklock's opinion that he would find encouragement for a second edition in Edinburgh led him to that city. He received the patronage of the Scottish gentry. His Highland tour, his taking Ellisland, the declaration of his marriage, his acceptance of a commission as an excise officer at £50 per annum, the "horrid hypochondria pervading every atom of both body and soul," his feeling of "the rigid fibre and stiffening joints of old age coming fast over his frame," and his bidding farewell to his farm after three and a half years' trial, are all well known. Riding about 200 miles a week on excise duty, superintending the farm, entertaining admiring guests, writing poetry, casting up accounts, taking part in parochial affairs, and mingling in the social circles of his district, were distractions enough to ruin any man, even in robust health, who attempted to be gauger, farmer, and poet all in one, but to a frame overworked and a mind overtasked with anxieties from mere boyhood it was far more than enough. Burns never was a convivialist in the ordinary sense. He could not stand it. Every concession to the customs of good-fellowship was paid for by untold agony of feeling in every fibre of his enfeebled frame. The paltry gossips of a petty burgh exaggerated his compliances with the common dissipation into habitual debauchery, and made mirth of the Samson whom they wiled into the company of the false Delilah—drink. Scorning himself, and suffering from the scorpion-stings of remorse, he sought surcease from sadness and escape from pain in the nepenthe of the age—whisky. Overworn by work, oppressed by care, despairing yet aspiring, his frame quivering with gigantic passion, his mind full of wayward whims and far-reaching thoughts, rheumatism seized him, and a brief illness was closed by the paroxysmal grip of *angina pectoris*, 21st July, 1796. Only ten years before had he put forth an appeal for recognition as a national bard. He has made good his claim. He is Scotia's darling poet, and the world's admiration.

Robert Tannahill (1774–1810), fired by his fame, aspired to deck the Scottish thistle with diamond drops of the dew of song. He wove his verse as he plied the loom. His poems are lively, enriched with the charm of rural scenery and fine affectionateness, but in rather more than seventy songs he attains peculiar excellence, and nearly approaches the exquisite enchantment of his model. Alexander Wilson (1766–1813), like Tannahill, a Paisley weaver, but better educated, became engrossed with the poetic phrensy, and in 1790 issued a volume of verse. In 1793 he wrote "Watty and Meg;" it was published anonymously, and being ascribed to Burns, sold well. He went to America in 1795, undertook a large work on American ornithology, but died in Philadelphia before it was completed. Hector MacNeill (1746–1818), poet and miscellaneous writer, while pursuing a commercial career, cherished in secret a love for the muses. He was unsuccessful in business, but at last his poetry, by its truth and pathos, gained him fame, though not wealth. A legendary poem, "The Harp," appeared in 1789, "Scotland's Scaith," a sad tale of the misery of intemperance, in 1795. "The Links of Forth"—a poetical description of the carse of Stirling—and "The Woes of War," 1796. Latterly he acquired comfort, wrote some tales, enjoyed literary society, and delighted in hearing his songs sung by the belles of Edinburgh.

William Lisle Bowles (1762–1850) issued his sonnets in 1793, and in 1805 published "The Spirit of Discovery by Sea." His preface to an edition of Pope (1807) led to a most animated discussion on the true principles of poetic art, in which Byron, Campbell, Roscoe, and others took part. Besides many other poems—"Bowden Hill" (1815), "Ellen Gray" (1828), &c.—his "St. John in Patmos" (1832) is remarkable for sweet and natural sentiment and phrase. His "Little Villagers' Verse-Book" (1833) is simple and useful, pure and tender. His mind received the beautiful and the true, and reflected it in fine transparent diction.

Samuel Rogers, born in London, 1762, was a shrewd, observant, and business-loving banker, and yet a poet of

sweet, touching, correct, though neither profound nor enthusiastic genius. His "Ode to Superstition" was published in 1786, two years prior to the appearance in print of Collins' "Ode on the popular Superstitions of the Highlands of Scotland" (1788), which had been written in 1754. "The Pleasures of Memory" (1792) established his reputation, and has stood the test of time. "Columbus," "Jacqueline," and "Human Life" are minor poems of much merit—simple, pure, and well-conceived. His greatest work, "Italy"—slowly elaborated, finely descriptive, and "well-languaged"—is more even than classically calm, when we remember the exaggerated romanticism of Madame de Staël's "Corinne," the impassioned glow of "Childe Harold," and the actual experiences of Italian life in the Napoleonic struggles through which it had just passed. Following Goldsmith as his model, his careful composition, good taste, refined imagination, and choice of subject made him a classic author for many years before his long life closed in 1855. His house was one of the centres of social life in London. He was a severe wit, a brilliant conversationist, and though scholarly and poetic, a most successful commercial financier.

William Wordsworth, born 7th April, 1770, at Cockermouth, though he lost his mother in his eighth and his father in his fourteenth year, was more than most poets blessed with health, peace, and competence. He was early acknowledged as a poet among poets, but only recently has our culture made it possible to perceive in him the bard of nature and man. He is one of the most sagacious, high-minded, and cheerfully grave poets of his era. Mrs. Hemans has expressed the prevailing opinion of him as a finely sympathetic, healthy, original-minded interpreter of nature—

"True bard and holy! Thou art even as one
Who, by some secret gift of soul or eye,
In every spot beneath the smiling sun
Sees where the springs of living waters lie."

By some strange alchemy he transmutes everything into a quintessence of imaginative meditation. Thus he says—

"By grace divine,
Not otherwise, O Nature! are we thine."

He is at once reverent, manly, and sympathetic, having a high ideal of the powers of man, and of the power of hope to realize itself. He is less intense, compact, and select in his verse than some of his compeers, because he wished to express what he desired to suggest. It was while he walked over hill and vale, through moor and woodland, that he conned his thoughts and tested their rhythm, as on his way he

"Scattered to the winds
The vocal raptures of fresh poesy;"

and only when mind and ear were satisfied, did he give them visible being with pen or pencil. Human-hearted genuineness governed his whole nature, and though of passionate fervour originally, he schooled his emotions so faithfully under the guidance of nature, that he seemed too impassive and conventional, even when overweighting with judiciousness his energy of intellect and force of feeling. How otherwise could he have spoken of

"All the mighty *ravishment* of spring,
The stationary *blast* of waterfalls,
Or the more than silent sky."

Impressive strength, wealth of self-knowing life, a warm love of nature, a constant joy in "linking to her fair works the human soul," and an imagination that colours everything with the delicate hues of a sober but not sombre imagination, charm in Wordsworth and make him to us a man "circumfused with grandeur." He Platonizes as well as poetizes the world of men and things, and thus imparts to them "a presence that disturbs us with the joy of elevated thoughts."

His hard struggle for recognition began with his "Lyrical Ballads" (1798), which were received with ridicule by those whose ears found no fault with the monotonous, the clinking antithesis of Pope's couplets. "The Prelude," though commenced in 1799, and carried on till 1805, was not published till 1850; but "The Excursion," which was to have followed it, was issued in 1814. Byron calls it a "drowsy, frowsy poem." "Peter Bell" was composed 1798, "The Waggoner" in 1805, "The White Doe of Rylstone" in 1807, "Laodamia" in 1814, "Artegal and Elidure" in 1815, and "Dion" in 1816. His odes, sonnets, poems to liberty, and minor pieces are very numerous and various, alike in manner and value; but his "Intimations of Immortality" is a fine psychological revelation of reflective thought on the *eternality* of being. In 1843 he was chosen poet-laureate in succession to Southey, and died in 1850.

Sir Walter Scott, though born in Edinburgh 15th August, 1771, passed his early days among the hills and dales of the Borders—a district fertile in song, ballad, and legendary lore. Here the imagination of the poet and the novelist imbibed at once health and inspiration. Passing through the High School and the University, he became an advocate, and attended the courts while he cultivated literature. His first public outstep on the intricate path of fame was almost a misadventure. The 1796 edition of his version of Burger's "Lenore" and "The Wild Huntsman" was, he says, "in great part condemned to the service of the trunk-makers." German translations led to Ossianic imitations and "Border-ballad Collections" (1802), but at length he enchanted the world by "The Lay of the Last Minstrel" (1805), "Marmion" (1808), "The Lady of the Lake" (1810), "Rokeby" (1813), "The Lord of the Isles" (1814), and then enthralled it still more as "the Wizard of the North," who sent forth in nameless secrecy for years the brilliant masterpieces of his genius—the Waverley novels. Never from the Muses' spring did there aforetime flow forth in such splendour legends of chivalry, tales of romantic adventure, engaging pictures of common life, and picturesque realizings of Celtic character and lowland incident, such as have given the Saxon and the Gael an everlasting interest to the whole civilized world.

Lord George Gordon Byron (1787–1824), who succeeded to the peerage in succession to his grand-uncle in 1798, was born in London, passed his boyhood in Scotland, was educated at Harrow and Cambridge, and issued his "Hours of Idleness" in 1807. Pride of birth, talent, and passion, all mistrained, ruled him. He was as fiercely sensual as Rousseau, as astutely selfish as Voltaire, as wickedly witty and penitent as Pope, as eloquent as Burke, and as gifted as Landor. Had he been carefully nurtured to good issues he would have been mighty "to wield at will the fierce democratie," and been a leader in the House of Lords. As it was, his rhetorical power flamed into poetry with lurid brilliancy in "English Bards and Scotch Reviewers" (1809), and two cantos of "Childe Harold's Pilgrimage" (1812), on the publication of which "he rose one morning and found himself famous." He matched himself against Scott as a poetic romancist in "The Giaour" and "The Bride of Abydos" (1813), "The Corsair" and "Lara" (1814), &c. In 1815 he married, and in 1816 was left by his wife through "incompatibility of temper." He quitted his native land shortly afterwards with much theatricality of circumstance. His intellectual nature woke to higher inspiration, but his grosser passions took the reins, and never was Plato's allegory in "Phædrus"—of the soul being seated in the body as in a chariot, with a pair of winged horses, one excellent and the other vicious—more pathetically exemplified. In the difficult and troublesome charioteering of his life, he yielded now to one, again to the other, and seldom kept them in check, but drove them together in harmony. The third canto of "Childe Harold," "Manfred," and "The Prisoner of Chillon" are due to 1816; "The Lament of Tasso," "Beppo," and "Childe Harold," canto four, to 1817; "Mazeppa" to 1818, in which year also "Don Juan" was begun. In 1819 the Guiccioli liaison occurred; his entanglement in revolutionary plots, and his relations with Shelley, Leigh Hunt, and others, continued. "The Prophecy of Dante" (1820) was followed by "Marino Faliero," "Sardanapalus," "The Two Foscari," and "Cain," while "Don Juan" was carried on. "Werner" and "The Deformed Transformed" (1822), "The Age of Bronze" and "The Island" (1823), were speedily written. Then, when half of life's threescore years and ten were passed, a nobler glow suffused his spirit. He threw himself into the cause of Greek freedom, resolved to "stick by the cause as long as a cause exists." He became its hero and martyr, and the dazzling phenomena of his life closed suddenly, 19th April, 1824.

Walter Savage Landor (1775–1864) spreads before the reader a "broad and ample page" rich with the learning of all ages, but everything suggests the idea of translation, as if it were not the first fresh embodiment of a thought. It is statuesque, sometimes picturesque, but the life of life seems wanting. "Gebir" (1797), "Count Julian," a tragedy (1812) having the same theme as Scott's "Vision of Don Roderick," are his main English poems, but his "Imaginary Conversations," "Pericles and Aspasia," &c., contain more poetry in their prose than these do in their verse. Bryan Walter Procter ("Barry Cornwall") (1790–1874), in his "Dramatic Scenes" (1819), "A Sicilian Story" (1820), "Marcian Colonna," and "Mirandola" (1821), aspires to a place among the creators of the greatest dramatic era of England's literature, and in his "English Songs" really all but rivals them. A sound mind, a rich fancy, masterly power over words, rare tact in setting his thoughts, and a pellucid style enrich them all. Adelaide Anne Procter (1825–64), his daughter, has written some lyrics and legends so pure and winning that they hallow the soul like the voice of prayer. Thomas Aird (1802–76), without the blythe, lyric spirit, had the fine melodious tone of the great masters, and has imperishable claims. Arthur Henry Hallam (1811–35), son of the historian of "The Middle Ages" (1818) and "The Literature of Europe" (1839), has left some touching effusions in his "Remains" (1834). He was the early friend and inspirer of Tennyson, himself the most artistic and graceful of all the master-spirits of our age. Natural gifts, concurrent circumstances, and the taste of the times all combined to induce him to pursue the art and mystery of song. Of a constellation of lights he has become "the bright particular star," "the cynosure of every eye." His works are in all hands, his praise is on every lip, the admiring homage of every English reader is his. He selects poetic thought as naturally as "Hybla bees" appropriate the nectar of flowers, and he fits them with poetic phrase as deftly as they construct their cells. The poet's instinct is in him both a habit and an art; the touch and tone of each are perfectly harmonized into living melody. Robert Browning still sings "fine thoughts, good thoughts, thoughts fit to treasure up." D. G. Rossetti, as master of the new romantic school, compacts emotional ecstasy into simple and precise forms; his sister, C. G. Rossetti, sings with a gift as pure and musical; and Maria Francesca Rossetti shows how "The Shadow of Dante" (1871) has been laid on the family from the eminent commentator on the "Divina Commedia." Augusta Webster speaks with a plain clear voice in a mono-dramatic style, which strikes, affects, and stirs within us "intimate questionings."

Robert Southey (1774–1843) was a man both of vast aims and powers. No literary man had previously been so regularly industrious. Poet, essayist, biographer, critic, humorist, satirist, and scholar, he was besides a most assiduous correspondent and much interested in politics. His great epics, "Joan of Arc" (1796), "Thalaba the Destroyer" (1801), "Madoc" (1805), "The Curse of Kehama" (1810), and "Roderick, the Last of the Goths" (1814), though looked at with impatience in our day, are wonderful instances of capacity to build the lofty rhyme of the hexameter up into noble forms. The good things they contain are numerous, and were men wise enough to read them they would not be so ready to scorn. Many of his ballads and minor poems are pleasing alike to age and youth. "The Vision of Judgment" (1821) and "Wat Tyler" (1794) are perhaps more perused because of Byron's wild onslaught on their author, than some of his more meritorious writings. They cannot be popular with those who run and read. They require attentive minds and tutored ears; but their melody is masterly when patience has learned the secret of his well-chosen language. It is a lesson in art to trace the plan and decipher the purpose of Southey. His prose is clear, sound, perspicuous, and he spares no pains to make his meaning plain. He worked with power, will, and intelligence, and the results are valuable in the information they convey and the perspicuity of the language they exhibit. Few who have striven so assiduously have thriven so well. His lives of "Nelson" and of "Wesley" are works which many generations will peruse with pleasure and profit. If his powers are estimated by his influence on other minds, he was perhaps the most effective force in his own day in letters and social morals.

S. T. Coleridge (1772–1834) as a seminal intellect, though not as a productive worker, excited much speculative energy in the minds of men. As poet, metaphysician, critic, and eloquent expounder of fresh views, he charmed men into delighted disciples. He communicated by the very touch of his words the precious seeing of faith, and the magic of his voice and verse wrought like a spell to heighten aim, enlighten research, and brighten the horizon of imagination or intellect. The lyric sweep of his verse was sinuous as the sea-wave beating on the shore, and the logical efficacy of his understanding subordinated all reasoning to its power.

Joanna Baillie (1762–1851), in her "Plays of the Passions," produced tragedies which, for force of feeling and resonance of rhythm, are among the loftiest achievements of female authorship—though they suffer from "the fear and niceness" with which women must deal with the intenser emotions. Her "Metrical Legends" (1821) and "Fugitive Verse" (1823) enshrine nature, sentiment, passion, and incident in flexile and gracious forms—perhaps a little too classical, stately, and severe, though sometimes glinting with good humour. Thomas Campbell (1777–1844) had a feminine sensibility of spirit and fastidiousness of taste, yet a manly martiality of mind. His "Odes" have the tramp of the military in them. His poem on the "Pleasures of Hope" is strong and smooth, delicate, natural, and true. His "Gertrude of Wyoming" (1820) is a finely finished model of skilful versification. "Theodoric" (1824) is soothingly domestic, but "The Battle of the Baltic," "Ye Mariners of England," are the safeguards of the sovereignty of the seas. To him we owe the suggestion of the London University. Thomas Moore (1780–1852) is an Irish "dainty Ariel"—Pope's, not Shakespeare's—always on the flutter of a restless wing. Appropriately enough his *début* was made with "An Ode on Nothing." "National Airs" (1815), "Sacred Songs" (1816), "Lalla Rookh" (1817)—a metrical mosaic of much merit—"Loves of the Angels" (1823), are preserved butterflies of verse. His various money-making books may be read of in Lord John Russell's attempt on his "Life" (1852–56), which certainly will not "circle his name with a charm against death." Allan Cunningham (1784–1842) is a "credit to Caledonia," rather by the lyrical effusions contained in his "Poems and Songs" (1847), than his rustic epic, "The Maid of Elvor" (1832), or "Sir Marmaduke Maxwell," a dramatic sketch of which Scott tried to speak complimentarily in the preface to the "Fortunes of Nigel." Like Burns, whose "Life" he wrote and whose works he edited, he has enriched Scottish song with sweet outpourings of the heart. James Montgomery (1771–1851), Irvine-born but Sheffield-sheltered, has so won the heart of the churches as a Christian poet, that his memory survives even the seven-volumed epitaph of "Memoirs" with which Holland and Everett burdened it (1854–56). His larger poems do not embalm much poetry, but they preserve fine thoughts beautifully expressed, and his minor verses contain many "pearls unparagoned." Ebenezer Elliot (1781–1849) was a political rather than a poetical power in his "Corn-Law Rhymes," but he is in many other moods a happy versifier of the sympathies which burn within the rustic and the artisan, and make "the whole world kin;" for example, in "The Village Patriarch," "The Vernal Walk," "Wharncliffe," &c.

> "His books were rivers, woods, and skies,
> The meadow and the moor."

Leigh Hunt (1784–1859), though he luxuriated in nature, looked at it through books. He gives "a potent strain" to his expression, yet he does this so genially that it becomes one of the sources of his success. All his books, prose or poetry, are gay in spirit, buoyant in joyousness, having their English expression rather Italianized. He is an "Indicator" (1819–21) of good things, an admirable "Companion" (1830–32), a "Tatler" to whom one can listen with interest. He tells "Stories in Verse" (1855) gracefully. His "Wit and Humour" (1844), "Imagination and Fancy" (1846), are rich and sunny. "The Feast of the Poets" (1814) he prepares is exquisite; while the verse-products he supplies

from his own vineries are luscious and excellent. Henry Kirke White (1785–1806) aimed at flights above his strength of wing, and death destroyed rather than subdued his ambition. Southey has affectionately laid up his memory in divine amber. "Cliftongrove" and other poems (1803) indicate the powers that dwelt in this "darling of science and the muse." Charles Wolfe (1791–1823), by his "Lines on the Burial of Sir John Moore," has escaped an undeserved oblivion. His "Remains" exhibit feeling, taste, and refinement, though a keen disappointment induced "dreams of decay, of death and burial, and the silent tomb" too early realized. Yet not unmingled were they with such hope and faith as were given expression to in the single surviving "Lines of Herbert Knowles" (1798–1817), "written in the churchyard of Richmond, Yorkshire," which gave him "a name to live" among the humbly born singers of sacred song. John Wilson (1789–1854) struck everyone who beheld him as an inheritor of a wealth of life. His magnificent physique realized Plato's "immortal animal" fully, and he might justly have been looked to for the highest achievements of genius in his generation. None of his published works —"Isle of Palms" (1812), "City of the Plague" (1816), "Noctes Ambrosianæ" (1855–58), "Lights and Shadows of Scottish Life" (1822)—unless perhaps his "Essay on the Life and Genius of Burns" (1841), communicate any idea of the whole greatness of indwelling power felt in personal relations with him. Henry Hart Milman (1791–1868) had also an imperial form, but the impression was marred by cold pomp and frigid dignity. His "Fazio" (1815), as a tragedy, yet keeps the stage. The "Fall of Jerusalem" (1820), "The Martyr of Antioch," "Belshazzar" (1822), and "Anne Boleyn" are all dramatic in form, not in power. "Samor, Lord of the Bright City"—*i.e.* Gloucester—(1818), is an epic of the Saxon invasion. He was professor of poetry, wrote a life of Horace, and was a most miscellaneous writer. Percy Bysshe Shelley (1792–1822), tall, slight, delicately organized, yet muscular, suggests his own phrase, "power girt round with weakness." His poetry is flowing, energetic, enthusiastic, and ethereal, but passioned with the hungers and thirsts of earth. In "Julian and Maddalo" he portrays himself and Byron. Keats, in "Adonais," is mourned with sweet sadness. "Epipsychidion" (1821) is magically musical and mysterious, but attractive. "Alastor" (1815) is an exquisite piece of dreamland. "Queen Mab" has poetical beauties and political absurdities of unexampled marvellousness, and is often replete with the very music of the spheres. "Cenci" is gloomy and fiendish. "Prometheus Unbound" is lyrically Greek. John Keats (1796–1821) was one of the greatest young poets who wrote in our language. "The Eve of St. Agnes" is "beautiful exceedingly." "Endymion" is classically chaste and wonderfully fair. "Hyperion" is surpassingly poetical in diction, and imagination beams brightly through it all. "The Ode to the Nightingale" is sweet and soft as the bird's song, suffused with a spirit of subtle pensiveness and ardour of desire. Thomas Hood (1798–1845) was a poet of fine poetic sense and "right happy dexterity of art," reduced by the necessities of this money-loving world to play the *farceur*. Only to read "Miss Kilmansegg" is to see the truth of this criticism. The poetry is the essence, and the jugglery of word-play is the embossed art. It is provoking that "joking" should be so coupled with the name of one of our most delicate singers. Robert Pollock (1799–1827) has most nearly attained the epic grandeur of the Miltonic muse. In his "Course of Time" he went on, despite the hand of death upon his breast—

> "Working his way
> With mighty energy, not uninspired,
> Through all the mines of thought, reckless of pain,
> And weariness, and wasted health,"

to grasp the poetic laurel. George Croly (1785–1860) wrote verse tuneful and sweet, bold, rapid, and many-toned. He had extraordinary power and aptitude. This is abundantly shown in "Paris" (1815), "The Angel of the World" (1820), "Catiline" (1822), "Gems from the Antique," "The Modern Orlando" (1846), a satirical poem, in "Salathiel," a romance; "Marston or Memoirs of a Statesman," "Tales of the Great St. Bernard," and his "Life of Burke."

In 1800, the year of Cowper's death, "The Farmer's Boy," by Robert Bloomfield, was, through the aid of Mr. Capel Lofft, published, and in three years 26,000 copies were sold. Its author was the son of a poor tailor, who "learned in suffering what he wrote in song." An elder brother, George, a shoemaker in London, undertook to teach him that trade. He became a good workman and a well-informed person. Charmed with Thomson's "Seasons," he was stirred to versification, and devoted himself to the study of expressive phrases. His "Rural Tales, Ballads, and Songs" (1802) won reputation. It was followed by "Good Tidings, or News from the Farm" (1804), "Wild Flowers" (1806), "Banks of the Wye" (1811), and "Mayday with the Muses" (1822). He died 19th August, 1823. His poems give fresh and faithful reflections of English rustic life, with its interests of "corn, horn, wool, and yarn." The taste, accuracy, melody, and elegance of Bloomfield's verse still charm, for as Bernard Barton says—

> "Words, phrases, passions pass away,
> But truth and nature live through all."

Thomas Hervey, who was born near Paisley, 1804, but removed early to Manchester, is one of the best of the minor poets of England. His "Poetical Sketch Book" is full of felicitous and interesting verse, and his productions in "The English Helicon" (1841) hold a good place among the choice contributors he collected. He edited the *Athenæum* 1846–54, and died 1859. His wife was a favourite contributor to Annuals, Keepsakes, Offerings, &c., in their heyday. Born in 1811 at Liverpool, she published in 1833 "The Bard of the Sea Kings," in 1839 "The Landgrave," a dramatic poem, wrote several novels—"Margaret Russell," "The Double Claim," &c.—and edited her husband's poems (1867). Thomas Haynes Bayley (1797–1839), besides numerous stories, essays, and dramas, has written a large number of pleasingly fanciful and refined songs. A memoir prefaces his "Poetical Works," edited by his widow.

Mary (Blackford) Tighe (1773–1810) was the daughter of a clergyman, whose married life was unhappy and whose later years were afflicted with ill-health. "Psyche," the poem on which her reputation chiefly depends, was printed in 1805 for private circulation, and only published in 1811, after her death. It consists of six cantos, in the Spenserian stanza, and is founded on the classical story of the loves of Cupid and Psyche in "The Golden Ass" of Apuleius, and is, while tender, pure, and ingenious, "wrapped in perplexed allegories."

Lætitia Elizabeth Landon (Mrs. Maclean), 1802–1838, early acquired a popularity scarcely exceeded by any British writer as a poet and novelist. Her genius was original, and her works glow with poetry. Song was with her an instinct that grew into a passion. Her industry was intense and untiring. Woven out of her brief life, she has left the world "The Fate of Adelaide" (1820), "The Improvisatrice" (1824), "The Troubadour" (1825), "The Golden Violet" (1826), "The Venetian Bracelet," "The Lost Pleiad" (1829), and "The Vow of the Peacocks" (1835), with an innumerable variety of minor verses scattered with profusion through the periodicals of her time, signed L. E. L. Besides these we have the novels "Romance and Reality" (1830), "Francesca Carrara" (1834), "Traits and Trials of Early Life" (1836), "Ethel Churchill" (1837), and "Duty and Inclination" (1838). Her life was fitful, and she says

> "Blame not her mirth who was sad yesterday
> And may be sad to-morrow."

Her lonely death, whether the result of murder, suicide, or misadventure, in Cape Coast Castle, is one of those truths stranger than fiction which, as Landor wrote,

> "Shall thrill our England's heart for many linkéd years."

SECTION II.—NOVELISTS: EDGEWORTH AND AUSTEN TO DICKENS, THACKERAY, AND TROLLOPE.

Maria Edgeworth (1767–1849), daughter of R. L. Edgeworth, an ingenious mechanical philosopher and an enthusiastic philanthropist, was born at Reading, educated by her father, and early co-operated with him in his educational and literary pursuits. In this way several schoolbooks were produced.

besides essays on "Practical Education" (1798) and "Irish Bulls.' She began the writing of novels in Ireland, and published "Castle Rackrent" in 1801; then followed in quick succession "Belinda," "Leonora," "Patronage," "Frank," "Harrington," "Ormond," "Moral Tales," "Tales of Fashionable Life," &c.—a singular clever series of smart stories, full of quiet humour and interesting incident characteristically representative of Irish life. These induced Sir Walter Scott to undertake the realizing of the common current of Scottish country existence. Jane Austen (1775–1817), born at Steventon, Hampshire, wrote "Pride and Prejudice" in 1796, "Sense and Sensibility" in 1797, and "Northanger Abbey" in 1798, though the second was not published till after revision in 1811, the first in 1813, and the last posthumously in 1818. "Mansfield Park," "Emma," and "Persuasion" were written in 1811–16. The grace, beauty, and freshness of these carefully elaborated products of an independent genius, nourished in a quiet rural parsonage, without literary associates and almost without hope of literary repute, have been acknowledged on all hands. They have as their bases sound sense, moral principle, and independence of genius. Their satire is exquisite yet delicate, and all her heroines are not like herself, handsome, graceful, amiable, and shy.

Barbara Wreaks (1770–1844), born in Sheffield, is, under the name of her second husband, T. C. Hofland, the landscape painter, familiar to every reader of English fiction of an improving and elevating type; and so is also the widow of another famous painter, Amelia Alderson (1769–1853), who married John Opie in 1784, and began a career of authorship in 1805 with the publication of "Adeline Mowbray." In 1834 she issued her "Lays for the Dead." She survived till 1853. C. G. Moody—Mrs. Gore (1799–1861) was one of the freshest, richest, raciest popular and prolific writers of fiction. More than 200 volumes own her authorship, and yet many magazine papers and other compositions are uncollected. "Theresa," "Marchmont," "The Lettre de Cachet" are graceful, well-finished blendings of reality and imagination. "Women as they are," "Mothers and Daughters," "The Fair of Mayfair," "Mrs. Armytage," &c., are pretty close satiric chronicles of current fashionable life, its vices, follies, and amusements. The brilliant vivacity of their wit was only equalled by their refined social wisdom and *bonhommie*. In "The Woman of the World," "The Heir of Selwood," "The Cabinet Minister," as well as in "Cecil" and "Cecil, a Peer," the knowledge of club life and the learning mystified the public. "The Banker's Wife," "The Money Lender," "The Dean's Daughter," "Mammon" glitter with jest and epigrams. Her ideal of life is not lofty, and the morality is of a home-spun sort, as to making the best we can of circumstances. The memory of them is pleasant.

Mary Russell Mitford (1786–1855) is a delightful and versatile writer. The daughter of a clever, eccentric, and thriftless father, she saw, knew, and experienced much. She had a picturesque intellect, and all that she thought formed tableaux in her mind. Before she was twenty, three volumes of verse had drifted from her pen-point, and yet, after a snubbing from the tartarly "Quarterly," she gave "Wattlington Hill" (1812) to the press. How genial, fresh, and faithful are "Our Village," "Stories of Country Life," "Belford Regis [Reading], or Sketches of a Country Town" (1854), and "Atherton!" Their great truth and lively interestingness, their open-air and sunshine, show the light and shade of English existence in Berkshire. Then, besides many other dramatic scenes, she supplied the stage with "Julian" (1823), "The Foscari" (1826), "Rienzi" (1828), "Charles I.," "Otto of Wittelsbach," Inez de Castro," &c., in several of which Macready played the leading *rôle*. Her "Literary Life" contains some delicious gossip about "books, places, and people." Miss Sidney Owenson (1786–1859), daughter of an Irish actor, lyrist, and composer, was a most voluminous and versatile writer. By a volume of poems issued early, and her "St. Clair" (1804), "The Novice of St. Dominick" (1805), but especially "The Wild Irish Girl" (1806), she won her way into society. Many other volumes followed, and a comic opera, "The Whim of the Moment," had a brilliant success in 1807. The two national tales, "O'Donnell" (1815) and "Florence M'Carthy" (1816), attained celebrity. Having spent much time abroad with her husband, Sir T. Charles Morgan, Knight and M.D., to whom she was married in 1812, she composed "France" (1818) and "Italy" (1820). Besides a romantic biography of "Salvator Rosa" (1823), "The O'Briens and The O'Flagherties" (1827), "The Princess or the Béguine" (1835), and "Woman and Her Master" (1840), a vindication of the merits of women, she collaborated with her husband—who wrote "The Philosophy of Life" (1818) and "The Philosophy of Morals" (1821)—in "The Book without a Name." In all her writings vivacity, vanity, and variety are conspicuous, but her autobiography is verbose and wearisome. Marguerite G. Power (1790–1849) was born in Knockbrit, Tipperary, brought up in Clonmel, and was married to Captain Farmer before she was fifteen. In 1817 Farmer died in a drunken frolic, and in 1818 his widow became the wife of the already twice-widowed Earl of Blessington, who died in 1829. After this she returned to England and settled in Gore House, Kensington. Count D'Orsay, who had married her stepdaughter and separated from her, dwelt in the same mansion, which acquired great notoriety through him in the empire of fashion, and through her in the republic of letters. She was most industrious in the business of book-making—edited "The Book of Beauty," "The Keepsake," and "Gems of Beauty." She had previously written "The Idler in France" (1839), "The Idler in Italy" (1841), and was esteemed the most delightful of female writers. At the circulating libraries her "Magic Lantern," "Repealers," and "Victims of Society" were much in demand. "The Two Friends," "Meredith," and "The Governess" are clever and fanciful. In "The Confessions of an Elderly Gentleman," who has been in love six times, she details the separate history of each with fascinating frankness, ease, and elegance. Its counterpart, "The Confessions of an Elderly Gentlewoman," regarding the intricately-woven tissues of her loves, cares, hopes, disappointments, and sorrows, was looked upon as a marvellous piece of moral anatomization. "The Belle of the Season" and "The Lottery of Life" are merry and sad by turns; refined caricature and winning good humour make them amusing and pleasant. While pouring out in these and numerous other works marked by ripe power, lively ridicule, shrewd observation, elegant acuteness, and striking contrasts of incidents and manners, Lady Blessington was living extravagantly. She fled from her creditors to Paris, where Napoleon, who had been a *habitué* of her *salon*, was then president. On being asked by him, Are you staying long in Paris? she replied, I don't know, are you? Within four months she died in the Rue du Cerq, and lies buried at Chambourcy under a monument which Alfred, count D'Orsay, spent the last three years of his life in sculpturing. Under it he too was laid, 15th August, 1852. Marguerite A. Power, niece of Lady Blessington, as the authoress of "Evelyn Forrester" and other tales, very much excelled her aunt, whose biographer she became.

Mrs. Frances Trollope (1778–1863) was a rapid, industrious, able, and voluminous writer. Her works fill a large space in the book-shelves of a library. Left a barrister's widow in 1835, she, by dint of toil of brain and speed of pen, secured the upbringing of her numerous family, many of whom have, like her, taken to literature and rivalled their mother in the making of many books. Much of her life was spent abroad and in travel. Her "Domestic Life of the Americans" excited quite a conflict of criticism in Britain and the States. "The Widow Burnaby" (1839), "The Widow Married" (1841), "The Burnabys in America" (1843) show how she realizes character. "The Vicar of Wrexhill" (1838), "Michael Armstrong, the Factory Boy" (1840), "One Fault," "Jessie Philips," "The Three Cousins" (1847), and "Tremordyn Cliff" (1838) are novels of the domestic type. There are keen sarcasms and stirring incidents in "The Lauringtons, or Superior People," "Hargrave, the Adventures of a Man of Fashion" (1843), "Mrs. Matthews, or Family Mysteries" (1851), "Gertrude, or Family Pride" (1855), "The Lottery of Marriage" (1849), "The Attractive Man" (1846). These are a few, but even after these the "tale" is left half told, for memory is treacherous regarding the varied products of Mrs. Trollope's prolific pen.

So lately as 1854, there passed away from Edinburgh society,

a lady whom Sir Walter Scott, at the close of the "Legend of Montrose" (1818), greeted as a "sister shadow," the author of the very lively work entitled "Marriage." That was Susan Edmonston Ferrier, born 1782, aunt of James Frederick Ferrier (1808–64), author of "The Institutes of Metaphysics," editor of John Wilson's ("Christopher North's") collected works, &c. She displayed great skill in the delineation of national peculiarities, a keen sense of the ludicrous, genial wit and pawkie humour, as well as ability to construct a story. In 1818 "Marriage" appeared; "The Inheritance" followed in 1824, and "Destiny" in 1831. She comforted Scott with her sympathy in the gloom of his closing years, and after his death, retiring into a dignified and lady-like privacy, broke her magic wand beside the wizard's grave, but retained her fascinating power of intellect beyond threescore and twelve years.

As a miscellaneous writer, in width of range, variety of style and treatment, general excellence and uniform mastery, Harriet Martineau (1802–76) is unrivalled. From her early "Devotional Exercises" (1823), to "The Positive Philosophy of Comte" (condensed), 1853, and "Man's Nature and Development" (1851); from "Poor Laws and Paupers" (1834) to "Heath, Husbandry, and Handicraft" (1861); from "Essays by an Invalid" (1843) to "England and her Soldiers" (1859) and "British Rule in India" (1857); from "Traditions of Palestine, imaginative Sketches in the Holy Land in the Redeemer's Time" (1830), to "Local Dues on Shipping" (1857); from "The Rioters" (1826) and the "Turnout" (1827), to "The History of the Thirty Years Peace" (1850) and that of "The American Compromise" (1856); from exquisite tales in "Illustration of Taxation" (1834), and "Deerbrook" (1839), an English domestic story, to "The Hour and the Man" (1840), *i.e.* Toussaint l'Ouverture, and "The Freeing of the Slaves of San Domingo," and "The Settlers at Home"—what vast extremes, and yet all showing fine mind, high talent, honest work, and conscientious principle. Caroline E. S. Sheridan (1806–77), subsequently Hon. Mrs. Norton and Lady Stirling Maxwell, both as a poet and a novelist became worthily famous. She possessed Byronic directness and force combined with feminine taste and grace. In her novels the evils done under the sun by want of thought and wantonness of will receive exposition and exposure. We may name "Stuart of Dunleath" (1851), "Lost and Saved" (1863), and "Old Sir Douglas" (1868).

But for the warnings of waning space, the unusual facilities enjoyed by the writer of reading the riches of the circulating library, where, "endlessly fresh and new," the range of fiction seems almost exhaustless, might well make him garrulous. There are not only the Scoto-Irish authoress, Elizabeth Hamilton, whose "Cottagers of Glenburnie" (1808) is so striking and impressive in its fidelity as a representation of rural humble life in Scotland, but the humour-spiced and wisdom-fraught writings of Miss M. Corbet, in "Petticoat Tales" and other volumes, in which she was assisted by her sister; and Anna E. Bray, whose pleasant descriptions, fascinating traditions, curious anecdotes and well-worked-out plots made Devonshire a peopled place in one's imagination long ago. Her "De Foix" (1826), "White Hoods" (1828), "Warleigh, or the Fatal Oak," "Henry Pomeroy," "Trelawney of Trelawney," "Trials of the Heart," were exceedingly popular, and have since become classic. Then there are the "Self Control" (1811), "Discipline" (1814), and the (unfinished) "Emmeline" of Mary (Balfour) Brunton, and the Wexford-born Anna Maria (Fielding) Hall's "Sketches of Irish Character" (1828), and "Stories of the Irish Peasantry," which rivalled Banim and Griffin. "The Buccaneer" (1832), "Woman's Trials" (1834), "Uncle Horace" (1835), "Marion" (1840), and "The Whiteboys" (1845) form delightful reading. Later on came Julia Pardoe (1806–62), with "Tales and Traditions of Portugal" (1833), "Reginald Lyle," "Flies in Amber"—a series of tales—"The Jealous Wife," "Speculation," "The Wardens and the Daventrys," "The Rival Beauties," "Poor Relations," with ingenious plots, charming descriptions, and poetic tone. Her early poems, 1820, and her first novel, "Lord Morcar of Herewood," are almost unknown. Julia Kavanagh provides "The Three Paths" (1847), "Madeleine" (1848), founded on a pleasant fact in Auvergne history, "Nathalie" (1851), "Daisy Burns" (1853), "Grace Lee" (1855), "Rachel Gray" (1856), "Adele" (1858), &c. Her native Irish *verve* and her French training have imparted clearness, smartness, and *espieglerie* to her style. Lady Georgiana Fullerton (*née* Leveson Gower) gives sad and gloomy pictures of life and feeling in "Ellen Middleton" (1844), "Grantley Manor" (1847), "Lady Bird" (1852), but entrances by narrative power and dazzles by elaboration of diction. Maria Jane Jewsbury (Mrs. Fletcher), author of "The Three Histories," possessed rare endowments and peculiar powers—Wordsworth called her a gifted woman. Her sister, Geraldine E. Jewsbury, author of "Zoe" (1845), "The Half Sisters" (1848), "Marian Withers" (1851), "The Sorrows of Gentility" (1856), exhibits great, though somewhat unpolished, talent and distinctness of purpose. Mary (Botham) Howitt, in "Strive and Thrive" (1839), "Hope On, Hope Ever," and many other tales, besides her most pleasant novel, interesting alike for fireside or field, "Wood Leighton" (1843), her excellent translations of the novels of Fredrika Bremer the Swede, and Hans C. Andersen the Dane, as well as many ballads of much varied power, often daintily expressed, showed herself a companion mind to William Howitt, her husband, whose "History of Priestcraft" (1833), "The Rural Life of England" (1837), and the novels, "The Hall and the Hamlet" (1847), "Madame Dorrington of the Dene" (1851), and many other works, gained him a fair place among authors. Their first joint-production, "The Forest Minstrel" (1823), contains many fine poems. Richard Howitt's "Gipsy King" and other poems (1840), was edited by them while he was on his way to Australia, where he settled as a physician and composed "Australian Poems" (1845). It is a rare thing to see such talent and amiability in one family as that of the Howitt's. Howitt's *People's Journal* was an admirable periodical, and it has been stated that William Howitt's "History of England" reached a circulation of 100,000. Mrs Hubback, niece of Jane Austen, has attained a favourable position among novelists by her "Three Marriages," "May and December," "The Younger Sister" (1850), "The Wife's Sister; or, the Forbidden Marriage" (1851), "The Old Vicarage" (1856), "Malvern," "Life and its Lessons," "Agnes Milbourne," &c. Acuteness, liveliness, and shrewdness are combined in Selina Bunbury's "Coombe Abbey" (1843), "Evelyn" (1849), "Our Own Story" (1856); and the fascination of romance, no less than the sobriety of history, are notable in "The Star of the Court," "Anne Boleyn, Maid of Honour and Queen of England" (1845). Other works of travel, description, and history are due to her pen. Anna H. Drury made her literary *début* with "Annesley and other Poems" (1847), in the manner of Goldsmith and Crabbe, but devoted her industry afterwards, with much succees, to prose fiction in "Friends and Fortunes" (1849), "The Inn by the Seaside" (1851), "Light and Shade" (1852), "The Blue Ribbons" (1854), and several other vigorously sketched and gracefully told tales. Mrs Ellis (widow of the Polynesian missionary), as Sarah Stickney, acquired repute for "ingenious truth in artful fiction veiled," which she enhanced after her marriage with the historian of Madagascar. Her works are very numerous, and are distinguished by sagacity, honesty, morality, courage, and moral power. Her "Pictures of Private Life"—three series—are varied in plot, and tend to warn the erring and advise the weak, as well as rebuke self-confidence and encourage patience. Though appearing, in 1835, before the public with "The Songs of a Stranger" as her introduction, Louisa Stuart Costello (1815–70), daughter of an Irish lady who wrote "The Soldier's Orphan," a tale, in 1809, as romancist, traveller, biographer, and translator acquitted herself well. "Clara Fane" (1848), "Gabrielle" (1843), and "The Queen's Prisoner" are her best novels. To her brothers, Colonel Edward Costello and Dudley Costello, we owe "The Adventures of a Soldier" (1841), and "Stories from a Siren" (1855), &c.

Catherine Stevens, Mrs. Crowe, made her first literary effort in "Aristodemus," a tragedy (1838), much admired by a select few; her second, "Susan Hopely" (1841), a novel, was popular with the many. She translated Kerner's "Seeress of Prevorst" (1845), and composed "The Story of Lily Dawson" (1847), a novel of rare merit somewhat like Scott's romances.

Two strange collections of supernatural stories, "The Night Side of Nature" (1848) and "Light and Darkness" (1850), were followed by "The Adventures of a Beauty" (1852)—a secret marriage of a farmer's daughter and the difficulties resulting from it—and "Linny Lockwood" (1854), another domestic fiction of much force. Thereafter her power, not of imagining terrors and mysteries, but of expressing them in coherent form, ceased. Charlotte Bronté (1816-55) stamped the ideal with the perfect likeness of reality. "Jane Eyre" (1847) seized the popular fancy at once. Her sister Emily's strong-minded and intense "Wuthering Heights" and Anne's noticeable "Agnes Grey" appeared at the close of the same year. The three sisters—daughters of a poor eccentric Irish-born curate of Haworth—were all consumptive. Emily died 1848, Anne 1849, Charlotte struggled on—writing "Shirley," 1849, "Vilette," 1853, marrying June, 1854, and dying 31st March, 1855. Her first novel, "The Professor," was posthumously issued. Elizabeth C. Stromkin (Mrs. Gaskell) produced in "Mary Barton" a faithful, painful, but intensely interesting picture of the industrial classes in manufacturing Manchester in the bad times, when political agitation and strikes wrought themselves into the very souls of "the factory hands." The Crabbe-like realism of this narrative and of "The Moorland Cottage" (1850), "Ruth" (1853), and the collection of stories entitled "Crawford," was maintained in her best representation of the characters and habits of the operatives in industrial centres, "North and South" (1855), while her "Life of Charlotte Bronté" (1857) revealed a romance in real life of which the truth was stranger than fiction. Everybody knows the charm of Dinah Muloch (Mrs. Craik's) finely-toned and well-told tales, and Margaret Wilson's (Mrs. Oliphant's) fertility in fiction of a graceful, simple, and truthful kind. The well-constructed stories of Miss Yonge are happily conceived and carefully composed; Miss Ann Manning's modern antiques are wonderful studies; Elizabeth Missing Sewell's novels, ballads, and historiettes interest and instruct; while Anne Caldwell's (Mrs. Marsh's) works of fiction are ripe in thought and rich in incident, worthy from their structure to be held as standard novels.

George Eliot was the pseudonym of Marian Evans—Mrs. J. W. Cross (1819-80). She was at an early age a ripe scholar. Hebrew, Latin, Greek, French, German, and Italian were familiar to her, and music was less an accomplishment than a joy. In 1846 she translated the "Leben Jesu" of Strauss, and in 1853 Feuerbach's "Wesen des Christenthums." She edited *The Westminster Review* and wrote for *Blackwood's Magazine* her "Scenes from Clerical Life." By "Adam Bede" (1859) she was made famous. The simplicity and quiet of English village ways and manners had never before been so distinctly and sweetly told. "The Mill on the Floss" (1860) was more passionate and subtle in its narration of the fate of the Tullivers. "Silas Marner, the Weaver of Raveloe" (1861), whose whole life is reinvigorated by the foundling child Effie, is a fine form of moral fiction. "Romola" (1863) is a splendid study of Italian history. "Felix Holt, the Radical" (1866) realizes the times of political agitation, like Charles Kingsley's "Alton Locke" (1850) and Thomas Cooper's "Autobiography" (1872). "Middlemarch" (1872) contains a gallery of provincial portraits of singular lifelikeness grouped around the heroine Dorothea Brooke. "Daniel Deronda" (1876) brings out the peculiarities of Jewish training and nationality with force and skill. As a novelist she realizes Wordsworth's lines—

> "The common growth of mother earth
> Suffices me—her tears, her mirth,
> Her humblest mirth and tears."

But as a poet she won a high place by her "Spanish Gipsy" (1868), in which she invests a tale of fate with interest, thought, and beauty, and "Jubal and other Poems" (1876). Her essays and other writings are all of weight and worth.

What a product of thirty-five years' labour are the prose "Works of Sir Walter Scott!" and in their innumerable editions what an immense amount of interest have they excited in the hearts of men! Freshness of thought, animation of style, plot-perplexities, scenic panoramas, healthy genial humour, and a gallery of portraits filling up the imagination and securing the interests of the intellect, commend him as a benefactor to all those who like to feel the throb of emotional life thrilling their hearts. "Waverley" (1814) makes vividly present to us Highland feudalism, the military valour and the singular incidents of "the Forty-five," and the scenery of Scotland, in which Captain Edward Waverley passed the adventure-filled intervals between his refusal by Flora M'Ivor and his acceptance by Rose Bradwardine. "Guy Mannering" (1815) peoples the south-west of Scotland not only with Meg Merrilees and the Derncleugh gypsies and smugglers, but with the robust and hilarious Dandie Dinmont, the shrewd and witty lawyer Pleydell, and the *gauche* but lovable "prodigious" pedant Dominie Sampson, and gives the touching history of the Bertrams of Ellangowan. "The Antiquary," "The Black Dwarf," and "Old Mortality" all appeared in 1816. The first brings the scenery round an eastern sea-port clearly before the eye, and represents the life of Scotland in the last quarter of the eighteenth century. Jonathan Oldbuck and Edie Ochiltree, and the Mucklebackit family of Musselcrag, are unforgetable. The second idealizes the misshapen brushmaker, David Ritchie of Manor Water, into the "cannie" Elshender, "the recluse," "wise wight" of Mucklestane Moor, *alias* Sir Edward Manley. In the third the author photographs Robert Paterson, a wandering antiquarian mason of Closeburn, and gives a rather harshly drawn delineation of the Covenant times, against the accuracy of which Dr. Thomas M'Crie recorded a protest in 1817. "Rob Roy" (1817), though an ill-woven and defective story, sketches the Highland scenery of the Macgregor country with great attractiveness, and by dint of the stirring interest of sturt and strife, the comicalities of the adventures of Bailie Nicol Jarvie, the troubles of the Osbaldistones, and the Jacobinism of Diana Vernon, fascinates the reader in despite of criticism. The pathos and interest shed upon the family of David Deans, cowfeeder, Edinburgh, the Laird of Dumbiedykes, Reuben Butler, Madge Wildfire and her mother in "The Heart of Midlothian" (1818) have seldom been surpassed, and the episode of the Porteous Mob is finely treated. "The Bride of Lammermoor," with its fine fatalistic unity of plot and action, tempered by the exquisite foolish fidelity of the butler of Ravenswood; "The Legend of Montrose," brief and imperfect as a story, but enlivened by the courage, conceit, coarseness, cleverness, and self-seeking of Dugald Dalgetty of Drumthwacket; and "Ivanhoe," with its masterly management of mixed materials—belong to 1819. This triumph of constructive skill seems as if at the close of the tournament it had reached a climax, but he leads us upwards to the storming of Torquilstone, beyond that to the deliverance of Rebecca by Sir Wilfrid, knight of Ivanhoe, the disinherited son of Cedric of Rotherwood; and when he weds Rowena we are compelled to follow with interest the love-lorn Jewess and her father, Isaac of York, as they leave England to seek the balm of bruised hearts—forgetfulness. Passing suddenly from the period of Richard Cœur-de-Lion to the times of the unfortunate Mary of Scotland and the regency of Moray, in 1820 Scott produced "The Monastery," with its sequel "The Abbot," in which Mary appears so queenly. Sir Percie Shafton reproduces Elizabethan Euphuism, and Edward Glendinning, though in high and holy office duly intent and devout, forgets not his youthful days in Glendearg, nor the beloved Lady Mary of Avenel, while Christie of the Clinthill and Mysie Hopper, the miller's daughter, furnish matter for contrast. Having succeeded in his portraiture of Mary, he next gives in "Kenilworth" (1821) a companion picture of Elizabeth and her times. The use made of the ballad of Cumnor Hall and the "History of the Dudleys" is excellent, and the vigour, variety, and splendour of the tale are surprisingly kept up. "The Pirate" (1822) rushes over the sea to the northern isles, and gratifies the reader with the strange incidents that happen and the singular superstitions harboured in these distant districts. In "The Fortunes of Nigel" he, during the same year, brought Mary's son and Elizabeth's successor upon the stage, while he embalmed in literature the greatest educational benefactor of Edinburgh, George Heriot, in his Jingling Geordie. Three novels are due to 1823—"Peveril of the Peak," which, though long and heavy, contains many excellent things re-

garding Charles II.'s time well put, notwithstanding his making his Puritans rather dull and the Catholic Countess of Derby a Huguenot; "Quintin Durward," all astir with the mephistophelic misdoings of Louis XI. of France and his intrigues against Charles the Bold of Burgundy in the France of the fifteenth century, inwrought with the love adventures of the member of the Royal Scottish Archers from whom the story takes its name; and the slight domestic novel, "St. Ronan's Well," which gives us the inimitable Meg Dods of Cleikum Inn, the old East Indian Peregrine Touchwood, Captain Hector MacTurk, and the Rev. Josiah Cargill, with a sketch of Spa-life in the olden days. "Redgauntlet" (1824) includes several autobiographic items, reproduces the Jacobite times, and supplies the humorous yet pathetic story of that hero of a "gangen plea," Peter Peebles. "The Betrothed," founded on Welsh tradition, and "The Talisman," an artistic eastern tale, are elaborately finished and charming. As the harbinger of wreck and woe (1826) dawned, commercial ruin came upon Scott and found him resolute. "Woodstock" appeared; "The Life of Napoleon," published 1827, was written; "The Chronicles of the Canongate," "The Two Drovers," "The Highland Widow," and "The Surgeon's Daughter" came out the same year; "The Fair Maid of Perth" (Kate Glover), 1828; "Anne of Geierstein" and "The Maiden of the Mist," 1829. "Count Robert of Paris"—the chief hero of which is Hereward, the Varangian, and "Castle Dangerous," thrice taken between 1306–7, were produced in 1831, and then death warningly "touched his teeming brain" with paralysis. The end came 21st September, 1832.

Benjamin Disraeli, Lord Beaconsfield (1804–1881), son of Isaac Disraeli, critic and antiquary, in 1826 gained reputation by "Vivian Gray," which he heightened by many other novels—*e.g.* "The Young Duke" (1831), "Contarini Fleming" (1832), "Alroy" (1833), "Henrietta Temple" and "Venetia" (1837), "Coningsby" (1844), "Sybil" (1845), "Tancred" (1847), "Lothair" (1871). In his "Letters of Runnymede" (1835) he turned to politics, and subsequently became the moving spirit of "Young England," the educator and leader of the Conservative party, and prime minister of England. He was astute, brave, skilful, and adroit, possessed great rhetorical power and intellectual readiness, so that in politics, even more than in letters, he attained a singular pre-eminence.

Edward Bulwer, Lord Lytton (1805–73), left no pathway to fame untrodden, and achieved success in all. As an orator his range of knowledge and experience gave him great power, and as a politician his place was marked as influential—as even his "Crisis" (1834) shows and his colonial secretaryship proved. His translation of "Schiller's Poems and Ballads" (1844) and "The Odes of Horace" (1869) are both masterly. The satiric touches of "New Timon" (1847) and "St. Stephen's" (1860) vie with Dryden and Pope. "The Lost Tales of Miletus" have the very tone of Greek poems. His essays, "Caxtoniana," &c., are thoughtful, pleasant, and variedly wise. On the stage "The Lady of Lyons," "Richelieu," "Money," &c., have won plaudits from the choicest audiences. Between "Ishmael" (1820), "Falkland" (suppressed), "O'Neil" and "Pelham" (1827), and "The Coming Race" (1871), "The Parisians," and "Kenelm Chillingley" (1873), "Pausanias the Spartan" (1876), thirty novels sped from his pen. Their names are familiar in men's mouths as household words. Of his (prize) poem, "Sculpture" (1825), his "Weeds and Wild Flowers" (1826), and his epic, "King Arthur" (1848)—only excelled in poetic wealth by Tennyson's "Idylls"—the merit is high. So much ability and fertility, ambition so vast and success so varied, have seldom been seen. Perhaps his versatility made his ambition "o'erleap itself." If he has failed to attain the guerdon of a modern Milton he has gained the loftiest place among the literary men of a notable age. Lord Lytton's heir has achieved a real poetic fame in "Clytemnestra" (1855), "Chronicles and Characters" (1868), "Orval, the Fool of Time" (1869), "Lucile" (1860), &c. "The Life of Lord Lytton," as well as other writings, are held in high respect.

Charles Dickens (1812–70), with few of the advantages of birth or culture, but with the pith of a powerful will, rose from the ranks of lowly life to the position of a peer among the people. Experience wrote upon a sensitive mind many of the secrets of human life, and the photography of genius has reproduced for us many of these strange stories. His "Sketches by Boz" (1836) and his (unfinished) "Mystery of Edwin Drood" (1870) stand at the extremes of his career, and between these "an infinite deal" of inimitable work has been done. Somewhat exaggerated and overwrought to eccentricity much is; but brilliant facetiousness and splendid moral effects are combined in his melodramatic fictions. He created Little Nell and David Copperfield, Sam Weller and Mrs Gamp, Pickwick, Micawber, and Squeers, Dombey and Chuzzlewitt; he enriched Christmas time with exquisite stories, filled an "Old Curiosity Shop" (1840) with wonder, shrouded "Bleak House" (1853) with interest, made "Hard Times" (1854) enjoyable, satisfied us with "Great Expectations," and made "Little Dorrit" (1857) "Our Mutual Friend," besides bringing us "American Notes for General Circulation" (1842) and "Pictures from Italy" (1846). Dickens possesses power alike over mirth and tears; he wins the heart and cheers the mind.

William Makepeace Thackeray (1811–63), later in gaining his laurels than Lytton or Dickens, probably surpassed both in reserved power. Intellectually he caught the infection of the Goethean irony in Weimar, and personally felt the irony of fate in the fortunes and misfortunes of his career. Notwithstanding his indubitable genius, wit, originality, and worth, it was only in "Vanity Fair" (1846–48) that he found the key to fame. "Pendennis" (1850) is "a round, unvarnished" tale of the common life of an ordinary English gentleman and those who serve and surround him—seen from the inside. "The Newcomes" (1855) introduce "a most respectable family"—in whose character, condition, and doings not a few flaws are exhibited, and yet their story charms, while it disenchants. "Esmond" (1852) realizes the age of Queen Anne with an artistic skill in which every line tells and excites regret that the history of her reign was not, as he intended, written by its author. It was exceedingly unfortunate that the critics ran Dickens and Thackeray as rivals—the work of both was injured by their intentional avoidance of any common ground or incidents. He, like Dickens, died, leaving "Denis Duval" unfinished. His "Four Georges" (1860), "English Humourists" (1851), &c., are vivid and telling, and all his work is finished with careful study of effects. His daughter, Anne Isabella (Mrs Ritchie), exerts her father's craft skilfully, and in "Old Kensington" (1872), "Story of Elizabeth" (1863), "Miss Angel" (1875), "Village on the Cliff" (1866), and several other works has given evidence of fine narrative power.

Charles Lever (1806–72) stands, "like some tall cliff," high ahead of surrounding Irish novelists. John Banim (1800–42) was poet and painter, as well as delineator of "The O'Hara Family" (1825–26), "The Croppy" (1828), "The Smuggler" (1831), &c., in which he exhibits the criminal, revengeful, passionate character of his countrymen with tragic intensity. William Carleton (1798–1862) gave graphic touches to the "Traits and Stories of the Irish Peasantry" (1830), dramatic individuality to "Fardarougha the Miser" (1839), "Valentine M'Clutchy" (1845), "Willy Reilly" (1860), and in "The Black Prophet" (1847), "The Tithe Proctor" (1849), "The Evil Eye" (1860), told graver tales of suffering, vicissitude, and sorrow. Gerald Griffin (1803–40) is the prose Burns of Ireland—his genius irradiates every region of the Irish heart. "Holland-Tide" (1827) is subtly true, "The Collegians" enthralling, and his different shorter tales reveal the sunshine and shade of home and heart. T. Crofton Croker (1798–1854), in "Fairy Legends" (1825) and "Legends of the Lakes" (1828), has brightened "the land of the west" with fancy. "My Village" and "Barney Mahoney" are aglow with love and humour, while the Irish Munchausen "Daniel O'Rourke" (1828) excites side-shaking laughter. Samuel Lover (1797–1868) is droll and merry in "Handy Andy" (1832). He imparts oily grace to "Rory O'More" (1837), and he is vigorous and various in "Irish Sketches" (1837), and in "Legends and Stories" (1834). The "mirth, all atremble 'twixt a smile and a tear," the intense home-love of the Celtic spirit, and the darker underlife possible in Erin's pretty scenes, are all exhibited in his stories and songs. Lever's larger experience and wider range of thought brought greater variety and

imparted keener zest to his literary products. The unflagging spirit, the venturesome dash, the constant movement, and the rollick and frolic of "Harry Lorrequer" (1837) "Charles O'Malley" (1841), "Tom Burke of Ours" (1844), and "Jack Hinton" (1842) are inimitable. No one can settle in a phrase the varying characteristics of "The Dodd Family," "Devonport Dunn," "Luttrel of Arran," "The Bramleighs of Bishop's Folly," "The O'Donohue," &c., but all can feel the full flowing vitality of the author's racy run of wit and invention. Everybody knows how G. P. R. James (1801-60) brought his heroes "pricking over the plain," or befogged in some vale, or belayed by some accident in an inn, to the number of "seventy times seven," from his "Richelieu" (1829) and "Darnley" (1830), till "Fate" (1851) and "Old Dominion" (1856) closed the series. Yet to these he added almost as many historical and biographical works. "De l'Orme" (1839) "Morley Ernstein" (1842), "Gowrie" (1847), "Agnes Sorel" (1853) deserve reading. Captain Marryat (1772–1848), author of "Midshipman Easy" (1836), "Peter Simple" (1837), "Jacob Faithful" (1839), and "Poor Jack" (1840), exhibits the frolics, fun, and fancy of seafaring fiction. His daughter, Florence Marryat (Mrs. Rose-Church), has issued "A Harvest of Wild Oats," "Open Sesame," "Veronique," and many other novels of talent and takingness.

Of Scotch novelists, after Scott comes pawkie John Galt (1779–1839) with his "Ayrshire Legatees" and "Annals of the Parish" (1821), "The Provost" (1822), "The Spaewife" "Ringan Gilhaise," and twenty other novels marked by humour and truth, quaint phrase and clever dialogue, descriptive skill and striking incident. Andrew Picken (1788–1833) in "The Dominie's Legacy" (1830), "The Sectarian" (1828), "Mary Ogilvie," "The Black Watch" (posthumous), and many tales and stories, holds equal rank with Galt. Dr. D. M. Moir (1798–1851), beloved for his sweet and soothing poetry, imparts unforgetable interest to the "Life of Mansie Waugh" (1828). Dr. R. MacNish, "the modern Pythagorean" (1802–37), dashed off some singular and clever "Tales and Sketches." J. G. Lockhart, Scott's son-in-law (1794–1854), in "Valerius" (1821), "Adam Blair" (1822), "Matthew Wald" and "Reginald Dalton" (1824), illustrated Roman, Scotch, and university characters and doings. Michael Scott (1789–1835) was only known after his death to be the author of the famous sea stories "Tom Cringle's Log" and "The Cruise of the Midge." Captain Thomas Hamilton (1789–1842), brother of Sir William Hamilton, the most famous of the metaphysical thinkers of Scotland, kept the secret of his "Cyril Thornton" (1827) almost as well. Alexander Smith, poet and essayist (1830–67), tried with some success a "prentice hand" at fiction in "Alfred Hagart's Household"—containing many autobiographic touches. Leitch Ritchie (1801-65) enlarged the reputation he had gained by "Schinderhannes" (1848) and "The Game of Life" (1851), by his "Magician" (1853) and "Wearyfoot Common" (1855), &c. James Hannay (1827–73), in "Hearts are Trumps" (1849), "Singleton Fontenoy" (1850), and "Eustace Conyers" (1855), kept up the Scottish character for sagacity, humour, grip, and adventure. J. G. White-Melville brings out Roman life vividly in "The Gladiators" (1863); in "The Queen's Maries" (1864), "The White Rose," and "Market Harborough" (1861) he is boldly realistic.

SECTION III.—MODERN PROSE WRITERS AND THE PROGRESS OF POPULAR LITERATURE.

Of many other forms in which thought has been enshrined —but with a purpose reaching beyond the mere enshrinement of it—much might be said but cannot. The drama is becoming more scenic and sensational than the adumbration of life in poetic forms—Dr. Westland Marston; Douglas Wm. Jerrold, the greatest wit of modern times; Tom Taylor; Charles Reade—distinguished also as a novelist; John Oxenford, T. W. Robertson, Dion Boucicault, A. Halliday [Duff], 1830–77, and W. G. Wills have added to the stage's force. History has been revivified by the learned and thoughtful George Grote, dithyrambic Carlyle, erudite Macaulay, judicious Hallam, dignified Thirlwall, empassioned Froude, speculative Buckle, philosophic Lecky, painstaking Knight, &c. James Mill, the radical historian of India, and Sir Archibald Alison, the Conservative narrator of the changes in Europe, Molesworth, Freeman, M'Carthy, &c., are also among those who reveal the past. Masson's "Milton" is most truly entitled to regard as a history of the early Stuarts of England. In science and philosophy, Sir Wm. Hamilton, J. S. Mill, Herbert Spencer, J. H. Stirling, W. Whewell, G. H. Lewes, Hugh Miller, Sir John Herschel, F. D. Maurice, H. L. Mansel, Henry Calderwood, Sir David Brewster, Mrs. Mary Somerville, Miss Frances Cobbe, Darwin, Tyndall, Huxley, and Bain are all worthy of remembrance. Of prose writers possessing special literary claim and charm we must name Thomas De Quincy, the protagonist of the popular; Ruskin, the rhetorican; Matthew Arnold, the critic; Henry Taylor, the talented; Arthur Helps, the sage; Dr. Smiles, the pleasant encourager of self-help; Gilfillan, the gorgeous; and De Morgan, the multiplex. But embarrassment besets every attempt to enumerate all those who as benefactors to mankind have sown broadcast, in good books, living thought in loving words.

The fresh interest in the common relations and experiences of existence, and the additional importance attached to individuality resulting from the development of society, soon made themselves felt in literature, which is the voice of life. The passion of the revolution rushing into Byronic poetry, the higher ideal of humanity suggested by the advocates of cultured civilization set to song in Shelley's sweet but mistaken imaginings, the quickened sense of the beautiful realized in Keat's verse, the steady glow of the "Pleasures of Memory," and the buoyant expectancy of "better things to come" expressed in the "Pleasures of Hope," alike gave currency to the idea that social life was "standing on the top of golden hours." By the popular literature of our own era, the thoughtful, the earnest, the wise and the witty, the student of the past, the observer of the present, and the inspirers of the future, have all been brought into relation, and the practical diffusion of thought made visible "has made ours an era when joy of one is joy of tens of millions." What a quickening of intellectual power has been the result.

Early in the century Sidney Smith, wit, philosopher, and Christian teacher; Henry Brougham, the versatile kaleidoscope of all thought—except that which was poetic and transcendant; and Francis Jeffrey, in whose residence the incident occurred, resolved to commence *The Edinburgh Review*. On 10th October, 1802, the venture issued from the press. Unlike its predecessor of 1755–56, this was a success, and in it the ablest writers and the most virile and competent critics long continued to lead its readers in the paths of Liberal thought. After seven years' occupancy of the field, *The Quarterly Review* was instituted, 1809, to leven literature with Conservative opinion and influence. An antiquarian literary organ appeared, 1820–26 and 1828, as *The Retrospective Review*. In 1824 the *Côté Gauche* of Liberalism set up the Radical *Westminster Review*, and the philosophic Radicals balanced this in 1834 with *The London Review*, which, though conducted by J. S. Mill, was ultimately absorbed by Colonel Peronnet Thompson's more robust and demonstrative organ. Since then *The British Quarterly* and *The North British Quarterly*, *The Foreign Quarterly*, and many others have appeared and disappeared. Thereafter there arose the magazine era—giving perennial life to that which had been only sporadic when *Blackwood*, 1817, took the field, and *Tait* and *Fraser*, *The New Monthly*, *The Dublin University*, *Bentley's Miscellany*, and a multitudinous progeny which no man can fully number, much less fitly describe. In 1802 *Rees' Cyclopedia*, forty-five volumes, followed that of Dr. Ephraim Chambers. *The Encyclopædia Britannica*, begun in 1771, entered upon a fourth edition in 1806, and has admirably renewed its youth in a ninth edition. Dr. Brewster's *Edinburgh Encylopædia* (1808–30), *The Encyclopædia Metropolitana* (planned by Coleridge, 1815), *The London Encyclopædia*, *The Penny Cyclopædia*, which reappeared as *The English Cyclopædia*, and forms the basis of the excellently condensed and much improved recent reissue of *The National Encyclopædia*, and many other similar works, have become treasures of intellectual research, erudition, and information. To look at such works and compare them with the earliest encyclopædic

work England produced—the "Liber de Vita aut Moribus philosophorum poetarumque Veterum," by Walter Burley (1275–1337), which was published in 1473, and went through twelve editions before the fifteenth century expired, besides being translated into German and Italian—would do more than a hundred-paged disquisition to show the power of the popularization of knowledge. This is the idea which dominates the nineteenth century. The desire to humanize society by literature—cheap, trustworthy, apt, and compact—grows.

Many attempts were made to meet the wants of the knowledge-seeking classes, and at length, in 1826, the aim, as was the habit in those days, took form in the Society for the Diffusion of Useful Knowledge, which was incorporated by royal charter in 1832. Its objects were to supply books capable of assisting the people in self-culture, and the reduction of the price of books generally. Among the works issued or encouraged by it were "The Library of Useful Knowledge," 360 parts, *The Journal of Education*, ten volumes, *The Penny Magazine*, nine volumes, "The Library of Entertaining Knowledge," the "Working Man's Companion," &c. The Christian Knowledge Society, stimulated by the success of these efforts, produced *The Saturday Magazine*, and commenced an excellent series of popular works on literature, biography, science, and specially prepared fiction, at moderate cost. *Constable's Miscellany*, Lardner's *Cabinet Cyclopædia*, and Murray's Family Library rapidly introduced cheap, good, and varied works into the market. The trade, thus practically taught the value of the business-extension attainable through cheapness, speedily followed with several editions of the best writers. John Johnstone in *The Schoolmaster*—subsequently merged in *Tait's Magazine;* W. & R. Chambers, in their still famous *Journal*, as well as in their "Information for the People," *Cyclopædia of English Literature*, Popular Library, &c.; Tomlin's "Self-educator," Cassell's "Working Man's Friend," Sharpe's *London Magazine*, Hogg's *Instructor*, Howitt's *Journal*, and a perfect host of other aids to popular education and literary culture, were speedily (and are still being) produced to suit men's varying wants and tastes, and to enable all to gratify the eagerness with which in this age

"We search out dead men's words and the works of dead men's hands."

No National Union for the advancement of knowledge, the promotion of literature, the encouragement of science, the development of art, the culture of industry, the study of history, the refinement of manners, the elevation of social life, the ennobling of individual life, and the general diffusion of humanizing influences, is possible in a state so systematically carried on in the interests of individualism as Great Britain is; but the quickening power of the intellect of all classes is a certain indication that, in the future as in the past, the leadership of men shall be wielded by those who possess and exercise cultured thought, and that the national destinies must depend on the intelligence of the discerning many, who have learned from the great, the good, and the wise the riches manifold of those books which have been written by the world's chief minds—the thinkers of the race.

EXAMINATIONS.

THEIR PURPOSE AND AIMS—HOW TO PREPARE FOR AND TO SUCCEED AT THEM.

The duty—we shall not say task—of self-improvement is one in which many are engaged. They have become aware of the value of study as a means both of forming and informing the mind. Loyal and well-conditioned intellects feel the stir of an ambition to know and a desire to learn. A large, and, as we believe, an increasing class of such persons, eager for the possession of knowledge, and willing to labour assiduously in the acquisition of it, are using such means as are at their disposal for training, moulding, enlarging, and ennobling their natures. But many—making strenuous efforts, with the ardour which might be expected from those who enter voluntarily upon such a course of self-culture—are unable to find or to command the advantages of direct oral instruction of the kind they want, at the time, in the manner, at a cost, and in circumstances suited to their several necessities. Such students, having an aptitude for patient toil and quiet endeavour, find it difficult to determine, among the innumerable cross-roads and by-paths of knowledge, which to adopt as that which shall be to them at once stimulant, disciplinal, and practically beneficial. Seeking a course of mental exertion capable of resulting in training and in useful knowledge, and conscious in some way that not alone what is known, but also the mode by which it has become known, and the power which has been imparted to the knowing faculties in the process, constitutes education, these indomitable spirits are very often compelled to rely on their own determined energy of mind, or the chance accident of the range of books within their reach, and the aid or advice to which they can have access, for their attainments and progress. Pleasant as they feel the mental delight of a discursive ranging through many provinces of science or letters to be, it does not commend itself to them as satisfactory. They know that while, by a desultory course of reading, they may be acquainted with much, they may yet be really informed on little; for these miscellaneous acquisitions want the unity and method of a prescribed and systematic course of training, and fail in the disciplinal effect of definitely regulated educative study—study, that is, which forms and develops the mental faculties and accustoms the intellect to grasp, retain, and apply knowledge. Every real student aims at the acquisition of might of mind as well as the possession of accurate, extensive, and varied knowledge. The trained intellect which organizes all it knows or learns by the constructive power of well-ordered association is universally recognized as truly educated. Accurate knowledge is not gained by committing to memory trim and slim little statements of scientific fact or of philosophic theory, carefully conned from text-books of more or less value, but by the actual absorption into the mind of the thoughts or facts intended to be conveyed through the words used. Extensive knowledge is not rightly estimated by the mere multiplicity of things known, but by the mastery of them possessed, and the ready and certain associations by which one recalls—in any requisite order or sequence—the whole information laid up in the mind. Varied knowledge is not properly gauged by the numerical mass of the items with which acquaintance has been gained, but by the distinct and different topics of thought capable of being brought under the review of the mind whenever required, all co-operatively linked together by the fine living associations of a full, active, and energetic intellect. However resourceful therefore the self-educator may be in his mode of prosecuting those studies for which he has a taste, or for which the peculiarities of his position have given him inducement or facilities, he ofttimes feels the need of some means—as Dr. Arnold used to say—"of making distinct to him his knowledge and his ignorance." Even in the most ardent enthusiast after self-improvement, whose studies are carried on in isolation, diffidence tends to grow. He is conscious of defective means of securing correctness of apprehension and thoroughness of comprehension. He fears that he may have fallen into mistakes of method or of authorities on whom to rely. Suspicion haunts his mind that the results he has attained, or fancies he has reached, are either not entirely satisfactory or may not be found to be (as he supposes them) new. These difficulties tend to depress the mind, and take a large discount from the joy he feels in effort and the gratification he experiences in gaining power over books, thoughts, and things.

In these circumstances it is not to be wondered at that he should desire some effective sequel and supplement to his course of study—some means of at once testing and attesting his acquirements, of ascertaining and registering the results of his efforts. Such tests of proficiency are now very widely offered to those who are animated by a desire for self-improving studies by several examining bodies. All who are aware of the value of education, and of the mental industry and energy called forth in the acquisition of knowledge, admit the advantages of adequate and trustworthy examination as a stimulant to and a test of studies properly pursued. It is only when the learner prepares and studies merely for the purpose of passing an examination, instead

of placing the whole strain of his intellectual effort on the acquisition of the knowledge implied in the studies on which the examination is to be held, that he inverts the order of things and depraves study into grind and cram. Working upon a subject is quite a different matter from "working up for an examination," and undergoing drill to get through one. In the former case the student's attention is given to the acquisition of real and substantial knowledge for its own sake, and he engages in the pursuit of it with that spontaneity which is the characteristic of true mental activity; but in the other the aim is success in pass or class, distinction, honour, or advantage, rather than the gratification of a genuine aspiration to know a subject, and to have it holding a clear space in the vision of the mind. In the one the subject is the direct object of the mind, and success in the examination a subsequent and indirect one; in the other, the success occupies the direct field of the desires, and an accurate knowledge of a subject is regarded as only the main means of securing that. It is one thing to learn a special subject and to be questioned on it, that confidence may be had in the knowledge professed as knowledge possessed; it is another and a different thing to learn how to undergo a series of questions on a particular subject, with a fair likelihood of securing a pass on having undergone trial in any special department of knowledge with success. The aim is different, and the educative power is quite distinct.

Students who have given their best attention to such branches of knowledge as are included in the pretty wide series of "The Home Teacher," have had the opportunity of making a choice of subjects suited to a considerable variety of tastes and capacities. These have been presented in a form specially suited to those who aim at self-culture and are bent on understanding what they learn. By arrangement of matter, order of exposition, clearness of statement, and careful endeavours to place every topic under the student's eye in such a way as not only to convey knowledge but develop faculty, its contents have been made disciplinal and instructive; while, by articulate organization of parts and classification of statements, each subject has been exhibited in a methodical manner, and therefore in such a form as best favours true study and thorough examination. The more accurately explicit each statement is made, and the more natural and logical the associations by which part is linked to part, the more readily may it be acquired and reviewed, and consequently it is more easily studied in itself and prepared for examination. Everyone who engages, in whole or in part, in the series of studies placed before him in this book may be sure that he has a well-defined and carefully planned curriculum before him, and may depend upon it that—if he has devoted his attention with singleness of view to what it contains on any subject—he cannot fail to benefit by his exertions. So far as it goes it supplies a systematic course of initiatory studies containing quite enough, as a general rule, to provide the student with as much knowledge as is required in by far the greater proportion of non-professional examinations, and with a very considerable amount of that which is required in a number of preliminary professional ones. The book not only indicates but leads a good way along all the main highways of knowledge, and supplies such details of information in all the departments—selected for their interest, usefulness, and educational importance—as is sufficient to serve anybody who possesses himself of the facts to hold due place as a well-informed person.

Carlyle has indicated his belief that the university of the future will be a library of well-chosen books. In this one book the aim has been to supply a condensed library of self-culture—a book which, without any derogation to the value of oral teaching, may bring into the home some of those higher influences upon mind which secondary school studies and a university curriculum supply. These have been produced in a form likely to stimulate the mind to a liking for such studies, and to incline and enable it to grapple with and conquer the difficulties they present. Its special treatises are so combined as not only to be each complete in themselves, but all to form a general well-adjusted culture for men and women of all ranks and classes.

The old ideal of university life attached great importance to residence and the co-operative contact of mind with mind under such circumstances. But the idea that examination should be the heart and life of its system has never been forgotten. The university has laid such stress on examination, and has taken such pains to make it not only a powerful stimulus to study, but a certified criterion of progress, that examination overshadows culture, and so regulates not only the manner and the matter of study that the examiner is supreme over the teacher, and the professoriate is overruled by the examining statutes. So much had this become the case that men began to reason that if examination is the supreme end of college culture, a man may prepare himself how and where he will—if he submits himself to this crucial test, nothing more need be required of him. On this ground the London University was instituted in 1837 as an examining body, empowered to test the proficiency of those who presented themselves at its examinations, and to certify—by the conferring of degrees in arts, laws, science, medicine, and music on those whom it deems qualified—the possession of a certain explicitly stated amount of knowledge in those subjects. Ten years later, in a very suggestive pamphlet, the Rev. James Booth, D.C.L., propounded his scheme of holding examinations periodically in every part of the country, and the issuing of duly signed certificates of success in certain grades, which should form a condition of eligibility for employment. His suggestion has not been carried out in all its fulness; but, in 1855, on the recommendation of a commission, it was adopted, in a modified form, in the Civil Service. By an Order in Council, Civil Service Commissioners were appointed to examine into and certify as to the qualifications of young men *nominated* to junior situations in the public service. These examinations have now been arranged in three classes—(1) qualifying examinations, in which a minimum of marks, sufficient to show that they possess a fair acquaintance with the subjects prescribed, must be gained by the candidates; (2) limited competitive examinations, in which the candidates nominated as competitors are subjected to examination, and gain, generally according to their success, their choice in turn of the vacancies competed for; and (3) open competitions, in which at specified times and places, duly announced, subject to being found suitable in respect to age, health, and moral character, as many applicants as choose may sit for examination at any pre-arranged centre (having previously filled in a form of particulars and paid a fee), and those who acquit themselves best receive the appointments then open for competition.

A general view of the branches open to competition, of those restricted by nomination, and of those regarding which specific exception has been made, together with information as to age, character, qualification, subjects and times of examinations, &c., may be had in a "Table of Rules and Regulations" respecting the Home Civil Service, the Civil Service of India, the Army, &c., published under the authority of the Civil Service Commission, which may be obtained, at 1*s.* 6*d.*, on application at their office, Cannon Row, Westminster. Full regulations regarding all "open competitions" are promptly furnished, post free, on application (inclosing name, address, &c.) to the Secretary, Civil Service Commission, London, S.W.

The Science and Art Department of the Committee of Council on Education provide "royal exhibitions" at the School of Mines and the Royal College of Science, value £50 per annum, tenable for three years, determined by open competition annually in May. It also promotes local effort to provide science and art studies in provincial places, and furnishes the means of testing the success of the same by its own staff of inspectors and examiners. Its grants in aid are distributed according to the results of the examinations they institute and supervise. The Society of Arts conducts examinations in English, arithmetic, book-keeping, geography, shorthand, French, German, music, &c., in various towns in the United Kingdom, for success in which certificates and prizes—including the Albert prize of twenty-five guineas—are given. Sir Joseph Whitworth also founded a number of scholarships for the promotion of mechanical and engineering industries, open to all, in sound health, under twenty-two years of age, tenable for three years by persons who have spent not less

than six consecutive months in each of three consecutive years, and has attained sufficient skill in handicraft at the vice and lathe or (it may be) the forge and bench. They are granted under the supervision of the Science and Art Department, as are the royal exhibitions. In Trinity College, Dublin, and in the New University, Ireland, the degrees of B.A., M.A., LL.B., LL.D., &c., may be gained by passing certain examinations without residence—in the former at the University, and in the latter at certain local centres. The universities of Scotland have a considerable number of exhibitions and bursaries attainable (under certain conditions) by competitive examination. St. David's College, Lampeter, can confer the degrees of B.A. and B.D. The Archbishop of Canterbury is entitled to confer the Lambeth degree of M.A.—the examination for which is held in December—but the fee chargeable (£25 and a stamp duty of £30 = £55) makes it rather expensive. The College of Preceptors confers the degrees of Associate, Licentiate, and Fellow upon teachers of either sex, after examination, and grants certificates as guarantees of good general education at stated examinations in London and the provinces. The example set by this chartered body has been followed by the institution of the "local examinations" of Oxford and Cambridge, for junior students under sixteen and senior students under eighteen. These are held in local and colonial centres, and are open alike to lads and young women. To the successful among the latter, certificates conferring the title A.A., *i.e.* Associate in Arts, are given. The Scottish universities have also a scheme for local examinations in operation by success at which, for women the title L.A., *i.e.* Licentiate in Arts, can be acquired. The degrees of the London University are available for women as well as men. Cambridge promotes the "higher education of women" by instituting examinations and granting certificates under a syndicate by which the general scheme is managed. The Association for the Promotion of the Higher Education of Women has established many exhibitions and prizes for the encouragement and reward of candidates, and several scholarships at Newnham Hall, Girton College, &c., have been instituted in favour of successful competitors. The (as yet) unacknowledged privilege of being admitted (in an informal way) to the examinations for the degrees of the university have been arranged. Oxford has followed suit. The Royal Academy of Music provides, by local examination, for the testing and certification of musical culture, and encourages study of voice or instrument by several exhibitions, prizes, and honours. Trinity College, London, 1875, grants diplomas of Associate and Licentiate in Music, after examination in technical and theoretical knowledge at local centres in all parts of Great Britain. A considerable number of scholarships are available annually to students in theology, in Durham University; and many of the dissenting colleges, as the result of passing an examination in a promising way, undertake, in whole or in part, the expense of educating young men of good reputation and creditable acquirements.

It may be advantageous to note that many merchants, ship brokers and owners, business men in several branches of trade, several large manufacturing concerns and railway offices, accept the certificates gained at local and other similar examinations as, so far, evidence of fitness for clerks, &c., in their service; and that in several ways they act as passports to positions where some scholarship and proof of intellectual capacity are required—*e.g.* apprenticeships under chartered accountants, architects, civil and mining engineers, publishers, printers, booksellers, and in the higher descriptions of mercantile and industrial pursuits.

So far as regards professional pursuits preliminary examinations are required prior to entrance on any of them. In law, the solicitor requires to undergo an entrance examination in general knowledge—fixed by the Incorporated Law Society, and held in Chancery Hall, London, or in local centres—service, under articles, during five years, an intermediate and a final examination; and every candidate for the bar must either produce evidence of having passed a public examination in some university in the British dominions, or undergo a preliminary qualifying examination equivalent, on the average, to such a test. In the medical profession, a preliminary examination in general education must be undergone before commencing more specific studies. This also applies to general medical practitioners, apothecaries, chemists, dentists, veterinary surgeons, &c.—although the Universities of Durham and of St. Andrews possess the right to grant an M.D. degree to medical men whose personal position and experience are such as, in the estimation of the senatus, entitle him to consideration, if he has been in practice for fifteen years, and can satisfy them as to his professional knowledge. The fees for such degrees, however, are not only heavy, but require to bear a costly stamp duty.

It is impossible to supply in any condensed reliable form an authentic account of the regulations, conditions, modes of application, and persons to whom application may be made, in regard to the several examinations thus brought under the reader's notice. The conditions are considerably varied, and are in some cases variable from year to year. Both the terms and forms of admission to their privileges or advantages are nearly as different as their aims, objects, purposes, limits, requirements, fees, &c. The regulations are sometimes exceedingly minute, running through sections, subsections, and notes on these; and at others vague and indefinite, not only as to entry, but as to work. As a general rule information, in the form of printed regulations, is readily given or forwarded to applicants by special officials, though in regard to several general notices are given periodically or otherwise in the newspapers or other specific channels of information. This is the case, for example, with all the Civil Service examinations in which the competition is open, but in the others the suitable parties are reached by different means.

As regards the Civil Service, owing to the commission on the Playfair reorganization scheme, 1886, variations may occur at any time on receiving the sanction of Parliament: the most recent notices are those only on which reliance can be placed. As to the other examinations noted, information may generally be gained from a calendar, syllabus, prospectus, handbook, &c., issued by some officially recognized authority; and in reference to these also the remark holds good that only the most recent should be depended on as authentic. It is better to be uninformed than misinformed on such matters. While therefore we enumerate the possible examinations to which access may be had, we cannot usefully supply notes of the conditions, regulations, terms, &c.

"A new departure" is now in course of development for the extension of university education by lectures, classes, &c., held in different centres, and affording certain facilities for receiving collegiate instruction, authorized certification of proficiency, and special opportunities of universal relationship. These, while they bring the living voice and influence of duly qualified teachers into communication with the taught, do not abolish but rather intensify the need for book-study, and the preparation made possible to the student, in private, by practically encyclopædic elementary treatises arranged as in "The Home Teacher" for self-instruction. Every student who can should accept gladly the opportunity afforded by this university extension scheme; but even when more fully developed than it can be yet for several years, there must be many who will require to use such books as this as an aid to their toil in self-improvement. Many such will no doubt find their place at one or other of those centres of examination the existence of which we have registered, and acquire their certification of, if not reward for, the results of their studious home endeavours. Not a few, however, from difficulties of one sort or another, may need to labour assiduously in the acquisition of the knowledge which such a book as this contains, without having the opportunity of subjecting their knowledge to qualitative or quantitative test. By such the joy of intellectual activity or the felt possession of knowledge may well be esteemed as "an exceeding great reward." To them a regulated plan of self-examination may be commended by the reproduction, at stated times, of condensed *memoriter* epitomes of the several chapters, and a diligent recomparison of these transcripts from memory with the original matter. A method of self-test such as this may readily be pursued, and is certain to be beneficial in its results. But it is certain that those who carefully and conscientiously master with thoroughness the matter of this book, whether subjected to specific examination or not, must

feel the value of the intellectual improvement gained, and cannot fail in the intercourse of life, however restricted, to prove themselves the possessors of that true knowledge which not only is but gives power.

It may, however, to some, increase the utility of this book if we supply a few hints on preparation for examinations. The acquisition of knowledge implies that what we acquire is, (1) understood, (2) remembered, and (3) able to be reproduced in an applied form. The material of knowledge may be regarded as permanent, the forms in which it requires to be applied or employed are variable. Accurate knowledge once acquired is always, therefore, a possession, and stands us in stead under every trial. Every means which may simplify and facilitate exact knowledge is valuable; but the indispensable thing is positive possession of precise knowledge, held with a firm mental grasp. Thereafter comes the need for using it readily, and managing it in all ways to good purpose. This is greatly aided by learning to run over in review the principles and facts of what we know in various forms and arrangements, by training the mind to cool and deliberate consideration, so that a habit of concentrating the whole attention on any one point may be pretty well attained. The easiest and quickest ways of doing things are not of course to be neglected or despised; but a well-understood way is always the safest. Some things, as historical dates, geographical names and facts, tables of numbers, chemical *data*, scientific formulæ, and the like, must be stored up in the memory, and kept ever bright and fresh for use therein. Neat forms of expression, working, and arrangement deserve much care, and practice in these, as in other things, helps greatly to make the student perfect in their use. Make everything vivid and clear in the mind, and never be content to think you know. Revise and make sure. Analyze all operations; be certain of the real principles, trace every operation step by step, and accustom yourself to mature the matter and define the arrangement. In every examination consider carefully and deliberately the entire questions asked in any paper or on each subject before beginning to answer or work any; mark off those which can be quickly and easily disposed of—jot these down and get them off the mind; then turn the entire force of thought upon any question which presents apparent difficulty, or is likely to demand longer time or more deliberate care. Write legibly, number answers distinctly, work neatly, arrange carefully, avoid saying anything superfluous, and be slow but sure, rather than dashing and vague.

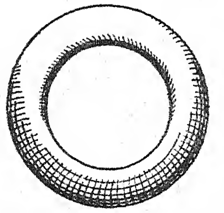
The purposes and uses of examinations may differ, but they may be classified as—(1) providing effective stimulus to effort and progress, (2) securing appropriate tests of attainments in knowledge, (3) affording means of recording and certifying competency and success, and (4) regulating the distribution of rewards—such as prizes, scholarships, exhibitions, degrees, place, promotion, &c. Rightly arranged examination should make certain—(1) the rejection of incompetent persons by settling a minimum of knowledge, falling below which no one can be recognized as fit to pass; (2) the classification of all persons examined and passed in the due order of their merit in regard to proficiency in the branches of knowledge under review; (3) the subordination of the persons examined, and who do pass in the lists, communicating the issue solely by the results of examination, and without application of any other principle for determining superiority, equality, or inferiority; (4) the thorough and acknowledged competency of the examiners; (5) the genuine impartiality of the examining body, regarded not only as a moral but a legal obligation; (6) the adequacy, uniformity, and fairness of the questions asked or exercises given; and (7) the self-sameness of the tests applied in the decision of the relative merits of the papers, replies, work, &c., given in for adjudication. These are the ideal conditions of trustworthily conducted examinations, and in each case as many of them as possible should be combined and realized, whether the examination is honorary, voluntary, or compulsory.

Examinations may be made useful (1) in giving a definite aim to study—if by due preliminary intimation the course to be pursued and the matter to be acquired have been explicitly pointed out. Half of the intellectual difficulty of any study consists in fixing the mind on a distinct subject and resolving to go on steadily in the mastery of it. When a prescribed path and a specific aim are presented to us indecision should be impossible, and fickleness of purpose out of place. They may (2) improve methods of study—by giving a clear idea of what actually requires to be done, keeping the object to be aimed at constantly before the mind, and inducing us to proceed carefully step by step from our present position or gain along the direct pathway of intellectual progress. They may likewise lead (3) to increased diligence in study—by fixing not only the amount of knowledge to be gained, but also the time that should be taken in its acquisition. We get thus two measurable things for help and guidance in our efforts. Knowing what is to be accomplished we can brace up our energies to the task, and having before us the limit of time, we have good ground for avoiding shortcomings, carelessness, or yielding to self-indulgences. Examinations may (4) greatly tend to increase exactness in our acquisitions. We may assure ourselves that definite answers or explicit work will be required of us in all examinable subjects. The pointed, precise, distinct, adequate, and yet concise reply; the correct, well-arranged, and rightly performed exercise—these are the delight of examiners. Hesitancy, haziness, or vagueness seldom, if ever, deceive anyone who knows his subject thoroughly. Sketchiness, indefiniteness, half-knowledge, either in phrase or form, betray themselves at once. Orderly, exact, and unmistakable statement ought to be aimed at by every examinee as it is expected by every examiner. Exact knowledge—of the kind possible in each subject of study—is alone likely to result in success in rightly conducted examinations; just as it is exact knowledge alone which is valuable as an acquisition of the mind. It may also be maintained that examinations properly organized, and conducted under genuine safeguards, might (5) do much for the general advantage of society in making study attractive and honourable, and in improving the general average of thought, interest, conversation, and aspiration throughout the land. Individuality is energetic, yet the drill of society is too often of such a nature as to reduce to a dead level of similarity all who move in it. The duty of being agreeable implies that no topics, except those of the most obvious nature and which can be handled extemporaneously, should be introduced in social converse, that any interest requiring higher than usual thought or knowledge is to be kept in the background, and that thoughts of inconvenient depth or difficulty should not be obtruded on those who should not be presumed to care for them or to be qualified to consider them. But if a general system of examinations heightened and widened our interest in knowledge, and gave certification of our power to deal with certain of its departments, the general possibilities of social intercourse would be extended and elevated, and a higher tone, on the whole, would gradually prevail. An infinitely varied play and interplay of talk would be acceptable to those who possessed knowledge, and those who only listened would do so with greater attention and benefit when they felt that those who spoke knew the topics upon which discourse was held. An additional attractiveness would thus be conferred on life, and conversation would attain freshness, vitality, and power by becoming a stimulant intellectual exercise. Nor would men and women be less entertaining and companionable when friendship, besides being a "sweetener of life," was also enriched by being made a medium for the transference of winsome wisdom from mind to mind.

THE END.

and varying in breadth from 1 to 2 inches according to the weight required. Its outer edge thins off, so that, as it passes from the hand of the player towards the hob, it may sink and stick into the ground, if soft, where it falls.

Formerly all quoits were made of iron; but it was found that these became, by use, rough and ragged on the edges, and injured the fingers. Brass and steel are now used for making quoits, which are much improved in their manufacture. Of whatever metal made, great care ought to be taken that after use they be thoroughly cleaned and dried, otherwise they too will rust and waste and be unpleasant to handle. Quoit players differ in opinion about the weight of quoits and the distances to be selected for the throw. Some prefer heavy quoits and short distances; others, light quoits and long distances. The former is more favourable to the development or display of strength; the latter, of skill. The quoit is held between the thumb and the fingers, the forefinger being placed along the outer rim, while the other three lie below and support it from beneath as assistants to the thumb. The quoit is pitched flat with such calculated strength that it may be carried to or near the hob, and with such skill as may ensure precision of throw. It is generally found necessary to impart a rotary motion to the quoit by the aid of "a twirl of the wrist," on the nicety of which good players pride themselves. The hob ought preferably to be of wood, gutta-percha, or cane; iron injures the quoit edge, and makes the quoit start and change its lie. There should be a hole in the top of it—through which a measuring string about 1½ yards long, protected by a button or pin at one end, may be passed so as to see accurately which quoit or quoits should be counted.


Quoit.

If there are more than three players it is usual to form sides. When this is done, and the order of playing has been determined, the members of the side which is to play first assemble round the hob from which the quoits are to be pitched, and the members of the other side gather round the other hob. Each player has two quoits—duly marked for recognition; each player on one side throws one quoit in turn towards the hob—endeavouring, if possible, to make it fall over the hob, or if that is not managed, to lie as near to it as may be, yet so that it shall stick in the soil, or at least make a distinct *dent* in it. When all on one side have thrown both quoits, the other side takes their place, and each pitches also in turn, as they did, one quoit one after the other, and then they play up the other. The number of gains is then counted—all those casts which have reached and lain nearer the hob than that of any one of the opposing side being reckoned. The winning side then has the first throw which is now made to the other hob, and the play proceeds as before. This order of playing, counting, &c., is governed by rules drawn up by eminent quoiters, and usually accepted as the rules of the game. The following technical terms are used to designate the throws:—(1) A *ringer* is one which hits the hob; when one side only makes a ringer, the success counts two; if a ringer is made by each side, neither is counted: they are quits. (2) A *sticker* is one which makes a distinct dent in the ground and lies where it falls. (3) A *dead* quoit is one which is disallowed for any reason, and such quoits are removed from the ground before any other player throws.

As a firm-footing is essential to a successful throw the player should keep his body as steady as possible, measure the distance over which the quoit must be carried, estimate the weight of the quoit and the relative muscular force which will be requisite to carry it where and as desired—making allowance for windage for or against its progress—and then, with his eye carefully fixed on the hob, let him play with will and skill.

Many quoiting clubs, and often different sets of players, have special rules of their own; but for general use we suggest the following set of rules, which probably may be found as satisfactory as any. They have been carefully revised from those in use by many of the best clubs, and are, in substance, recognized by the most competent players.

Rules of the Game.

1. The distance between the two hobs shall be [*from* 18 *to* 22 *yards*] as may be agreed on.
2. Each player shall throw two quoits from each end.
3. The order of playing shall be determined, by tossing or otherwise, before the commencement of the game.
4. No player shall leave the end from which the quoits are being pitched until the last quoit has been thrown from that end.
5. In a foursome game, two adversaries shall remain at each end while the quoits are being pitched.
6. Each party [whether playing one, two, or three on a side] shall determine among themselves, before the commencement of the game, what number of points is to constitute the game.
7. All measurements shall be made by the string fastened into the top of the hob, and no clay near any quoit shall be flattened, removed, or disturbed.
8. In case of dispute as to distances, an arbitrator may be called in—the arbitrator to be selected by the majority of those playing—and his decision shall be final.
9. Those quoits only shall count which *stick* or make a distinct dent *in* the ground, in which they can be placed, and where they will stay when the lip of the dent is pressed down. The measurement is to be taken when the quoits have been admittedly so placed in their true dent.
10. In all cases—except those mentioned in Rule 9—quoits that fail to stick, no matter what the cause, do not count.
11. The quoits that lie nearest to the hob count first; but when a ringer is nearest, that counts two.
12. If each player (or party) throws a ringer, neither scores anything.
13. Each player (or party) counts one point towards the game for each quoit that lies nearer the hob than any one of those that have been pitched by the opposite side—whether one player or a party.
14. The winner at each successive end is entitled to the next first throw.
15. All *dead*—*i.e.* disallowed—quoits should be removed from the ground before any player throws the next quoit.
16. A *sticker* (see Rule 9) is decided by drawing back the lip of the cut, if any, which a quoit has made in the ground.

CHAPTER XIII.

CYCLING.

The sport of cycling is one which has arisen only within the last thirty years, although machines similar in some respects to the bicycle were used considerably earlier. In 1808 there was introduced in Paris a form of bicycle called a "hobby-horse," consisting of two wheels in line, mounted in a wooden frame, astride which the rider sat, steering by the front wheel and propelling the machine by pushing the ground with his feet. This machine became very popular for a time both in France and England. About 1836 the first true bicycle was constructed by Kirkpatrick Macmillan of Penpont, Dumfriesshire, who fixed cranks to the axle of the back wheel, and connected these by means of levers with stirrup-like pedals with to-and-fro motion attached to the frame of the machine, the front wheel of which was used for steering. This was the first veritable *rear-driver*, but it seems to have attracted no attention at the time, and it was not until 1867, when there was shown at the Paris Exhibition a bicycle of wood in which the *front wheel* was driven by cranks and pedals directly attached to its axle, that the public awoke to the fact that a new form of sport had appeared. This machine, the invention of Pierre Lallement, speedily became popular in England and America, as well as in France, and the manufacture having been taken up in Coventry, the machine was rapidly improved by the efforts of successive inventors, who substituted a frame of light but strong steel tubing for that of wood, wheels of steel

wire with metal rims and tyres of india-rubber for wooden wheels tyred with iron, and adopted many ingenious methods of lessening friction in the bearings, and compensating the effects of wear upon them by re-adjustment. The size of the principal wheel was at one time enormously enlarged to increase the pace, and many other modifications took place which it is not necessary to follow in detail.

The introduction of the "safety" bicycle in 1885, in which the *rear wheel* was used as the driving wheel, and its speed in relation to the pedals was regulated by a simple form of chain gearing, greatly increased the popularity of the two-wheeled machine, and the invention of pneumatic tyres by J. B. Dunlop in 1888, made the pastime of cycling so much easier and more speedy, as well as comfortable, that the number of cyclists, by no means small even when difficulties were great, has since expanded year by year. The increasing interest taken by ladies in cycling has been greatly stimulated by these inventions, and an alteration in the shape of the frame of the bicycle has been devised which enables them to use it in ordinary dress. They have in consequence almost abandoned the tricycle, the smaller weight of the narrower machine being a distinct advantage to them.

The most popular form of the modern cycle, the "safety," is shown in fig. 1. It consists of a light framework of steel tubing, A B C, to which the two wheels are attached by means of the forks D, E, and F. The first of these carries the steering wheel, which is movable round an axis which passes through the centre of the tube B of the frame (called the head). This motion is governed by the handle-bar *h*, and is the means of steering the cycle. The rear or driving wheel is held between the ends of the two forks E and F, called respectively the lower and upper backstays, and can only be rotated on its axis in the plane of the machine frame. This wheel is impelled by the feet of the cyclist acting alternately on the pedals *p p*, which are attached to the ends of the short levers *m m*, called cranks, fixed on each end of the crank-axle, which passes (at right angles to the plane of the diagram) through a short tube in the framing called the bracket; on this axle is also fixed the toothed chain-wheel *n*, and a similar but smaller toothed wheel *o*, called the hub chain-wheel, is fixed on the hub of the back wheel. The two chain-wheels are connected by an endless chain, shown in the figure, the teeth of the wheels passing through the links, so that one wheel cannot be turned without also moving the other. Thus when the wheel *n* is turned by the pedals it draws the chain over the wheel *o* and causes it to revolve, thereby moving the driving wheel which is secured in the same axis. The number of turns which this wheel will make for each complete revolution of the pedals depends on the relative sizes of the chain-wheels *n* and *o*. Thus if *n* contains twice the number of teeth that *o* does, it is obvious that *o* and the driving wheel will revolve twice for each revolution of *n*. The bicycle wheels consist of the metallic rims *r r*, connected by spokes of steel wire with the hub or central part, and on these rims are fixed the pneumatic tyres *t t*, of india-rubber lined with a strong textile fabric, which can be inflated by injecting air with a force-pump through the valves *v v*. The saddle is shown at *g*, the handle-bar at *h*, and the brake, by which pressure can be made on the tyre of the front wheel, at *i*. This brake is commonly lined with soft rubber, and is moved by a lever *k* pivoted on the handle-bar. A clamp *l* enables the brake rod to be lengthened or shortened when the handle-bar is raised or lowered. The mud-guards *s s* protect the rider from splashing by the wheels in wet weather.

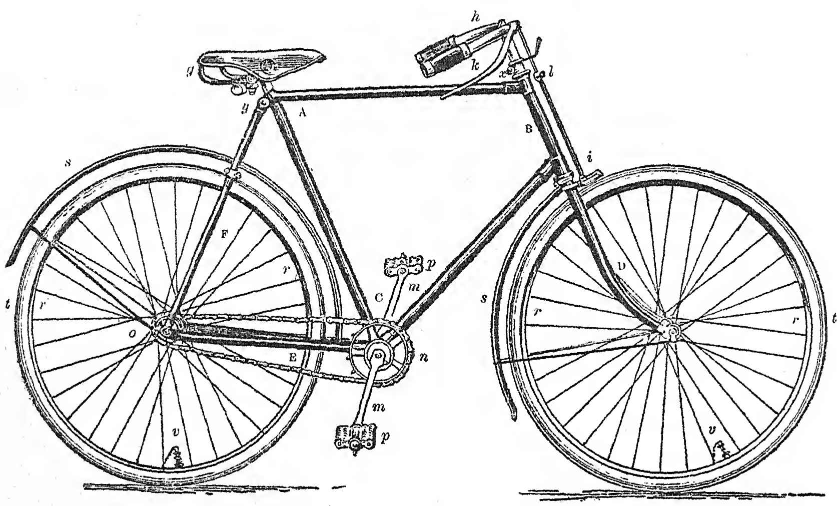


Fig. 1.—Modern "Safety" Bicycle.

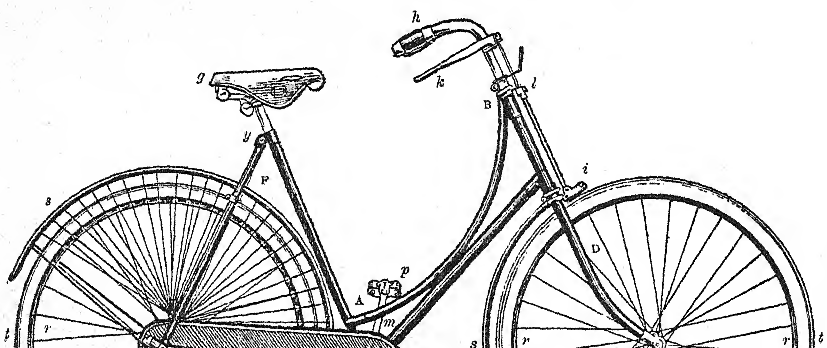


Fig. 2.—Ladies' "Safety" Bicycle.

The form adapted for the use of ladies is shown in fig. 2. The upper tube of the frame A B is here shown to be depressed in the form of a curve to give room for the skirt. The chain and gear-wheels are covered by the gear-case G.C., and the rear wheel is guarded by a series of cords proceeding from the mud-guard to a point near the axle on each side. The other letters in the figure correspond with the description above given. The shape of the ladies' machine still varies a

little in the productions of different makers. It has necessarily a weaker frame than that used by men, and should not be subjected to similar strains, either from the weight of a heavy rider or from riding over very uneven ground.

Our subject naturally divides itself into three sections: (1) Learning to ride the bicycle; (2) learning the uses of its various parts, and how to keep them in order; (3) the management of the bicycle on the road.

Bicycle racing has of late years become so thoroughly artificial in its conditions that it does not come within the scope of the present work.

In acquiring the use of the bicycle the beginner's first task is to learn to maintain the balance of the machine when in motion. The method is really very simple, and its sole difficulty arises from the need for *unlearning* most of what has previously been learned in the art of balancing. In standing on one foot, walking, running, &c., we balance the body above the foot, which is for the moment a fixed point, by moving the weight so as to keep it above the point of support. But the cycle is not a sufficiently fixed support to admit of this mode of balancing. It is constantly in motion, and it is, when being ridden, capable of being easily moved from side to side by means of the steering wheel and handles. The rider therefore sits as immovably as possible in the saddle, and when he feels any tendency to fall to one side he steers the bicycle so as to *bring the supporting wheels under his weight.* As soon as he has overcome the previously acquired tendency to move the body in order to maintain its balance, he finds the rest of his task comparatively easy, though of course there is much to learn in skilful pedalling, &c.

It is best therefore to begin by making yourself familiar with the steering of the cycle. This can be done by standing on the left side, grasping both handles and walking alongside the machine at a smart pace, guiding it by means of the handles and steering wheel, until you can without difficulty make it pass in all directions among stones or other irregularly disposed obstacles without perceptibly slackening your pace. When this stage has been reached, it is best if possible to enlist the services of a friend or teacher to help you to learn balancing in the saddle. While he holds the machine you mount the saddle, which had better be placed for the nonce so low that you can touch the ground on either side with your toes. Grasping the handles with both hands, place your feet on the pedals with the ball of the great toe above the centre tube of each pedal, and while your friend grasps you by a belt, or holds the back of your saddle to aid your balance, you should propel the cycle slowly forward on a smooth and level road, by depressing first the one pedal and then the other. The pace should be slow to enable your helper to keep up with you on foot, and you must now put in practice your knowledge of steering by guiding the machine always *towards* that side to which you feel any tendency to fall, until the point of support is felt to be under your weight, when the steering wheel should be put straight. After a period of practice which varies greatly with the activity of the learner, this motion will become automatic and cease to give you any concern when riding.

In cases where the learner cannot obtain the help of a friend or teacher, he must adopt a somewhat different method of learning the bicycle balance. Grasping the handles with both hands, he should stand astride of the back wheel as close behind the saddle as possible. Then placing the left foot on the *step* which projects from the left side of the hub, and resting his weight partly on it and partly on the handles, the machine should be urged forward by pressing the right foot backwards against the ground. If the path is level or very slightly downhill, one or two hops will give sufficient speed. Then by straightening the left knee and increasing the pressure on the handles, the body should be lifted entirely from the ground, and remain supported partly by the step and partly by the handles. A good deal of the weight should be rested on the latter, which must at the same time be manipulated so as to keep the front wheel always under your weight. When this has been thoroughly learned it will be found that the balance can be maintained in this position until the machine comes almost to a stand. To dismount from the step, the right foot, which has been on the right side of the back wheel, should be swung backwards over the wheel and placed on the ground behind the left foot, which can then be lifted from the step. This should be practised only when the machine is going slowly. To prevent slipping of the left foot on the step it is well to wear shoes with thin and flexible soles, or still better with india-rubber soles.

After the power of balancing has been acquired, the learner may proceed to get into the saddle as follows:—Standing on the step as above described, he watches until the right pedal has reached the highest point in its revolution. The right or disengaged foot is then placed upon it, and as it descends part of the weight of the body is transferred from the left foot to the right. This will increase the pace of the cycle, while the rider is gently lowered into the saddle as the pedal continues its descent. As soon as it has reached its lowest point, it is known that the left pedal must be at its highest. The left foot can then be removed from the step and placed upon the left pedal. Thereafter the propulsion of the machine is continued by pressing alternately on the pedals with that part of the foot which contains the ball of the great toe, and the balance is maintained as previously described. This is the most general method of mounting, but it sometimes happens when riding in streets, &c., that there is not sufficient space for it, or that the bicycle is constructed without a step. It is therefore useful to be able to mount it from the ground. To do this the rider should stand on the left side of the machine, grasping both handles, and move it forward until the right pedal is about one-fourth of its semi-revolution in front of its highest position. The machine being inclined a little to the left, the right leg should be swung over the back of the saddle, and the right foot placed upon the pedal. By pressing the toe of the left foot on the ground, the cycle can now be raised to a vertical position. As soon as this is reached the weight of the body is transferred to the right foot, with a steady pressure, and without sudden strain or jerk. This starts the bicycle, and as soon as the the right pedal has reached its lowest position the left foot can be placed on its pedal, then at the top of its circle, and the motion of the bicycle is maintained. This mount is adopted by ladies, except that they step over the frame of the cycle in front of the saddle to reach the right pedal. After proficiency has been attained in mounting from the left side, the same method ought to be practised from the right, as it is often convenient to be able to mount from either side.

Dismounting is generally effected by reversal of the above motions. When the speed of the cycle has been sufficiently reduced and the left pedal has just reached its lowest position, the rider, resting part of his weight on the handles and leaning a little to the left, should stand on the pedal as it rises, while he swings the right leg smartly over the back of the saddle, and places the right foot on the ground behind the left. If this is not done smartly, or if the cycle is travelling too fast, the left foot may be carried by the pedal over the top of its circuit, which is apt to cause a fall, but when the speed is not too great the act of rising on the left pedal brings the machine to a stand. Another method is to place the left foot on the step and rise upon it, the rest of the dismount being as above described. A beginner, however, incurs some risk of putting his foot among the spokes of the back wheel, and thus causing an accident, so this mode of dismounting is better adapted for the expert. It is also possible to dismount by bringing the cycle very nearly to a stand, and then leaning over to the left and placing the left foot directly on the ground.

The next stage is to learn the art of turning, which is done by inclining the body slightly towards the centre of the turning circle, and at the same time turning the steering wheel in the direction you wish to take. It will be found that the change in its course effectually prevents the cycle from falling inwards as might perhaps have been expected. The exact amount of inclination of the body required depends on the speed at which the cycle is travelling, and is only learned by practice, but it is useful to observe that the front wheel is so hung that it turns to any side towards which the cycle is inclined, so that very little effort is required of the hands. Too sharp a turn should not be attempted at first, but with

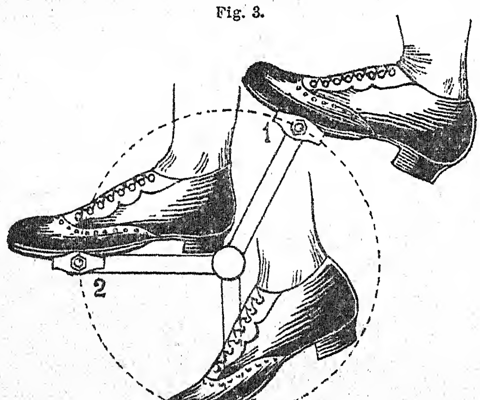
practice the movement will become very easy. The beginner should not attempt it on a wet road surface, as there is greater risk of slipping.

As soon as the cyclist has become tolerably proficient in mounting and dismounting, he should raise his saddle to a more comfortable position. This will vary to a certain extent with the individual rider, but the ordinary rule is to place the peak of the saddle from two to four inches behind a vertical line drawn through the crank bracket, and at such a height that the cyclist can place his heel on the pedal when at its greatest distance from the saddle. When the ball of the great toe is placed upon the pedal it can be followed through its whole circuit without entirely straightening the knee-joint, which conduces to smoothness of action. The height of the saddle is varied by sliding the saddle pin in the tube A C, fig. 1. It is held in position by tightening the clip *y*.

It is important for the comfort of the cyclist that the height of the handle-bar should be so adjusted that the handles can be grasped with ease, and without assuming a strained or unnatural attitude. If he prefers to sit in an upright position, the handles may be placed slightly above the level of the saddle, the exact height of course depending on the length of the rider's arms and the horizontal distance between the saddle and handle-bar. The bar may be raised or lowered by loosening the screw which holds the clip at the top of the steering head (*x*, fig. 1), and after adjustment this screw must be tightened again. The handle-bar should be fixed at right angles to the steering wheel. If the machine has a brake—and no beginner should use a machine unprovided with one—it is necessary also to slacken the screw *l* where the upper part of the brake-rod telescopes into the lower. This enables the rod to be lengthened or shortened as desired. It should again be tightened as soon as the adjustment is complete, and care should be taken that the brake can be brought with sufficient force against the tyre of the wheel by grasping the lever.

The art of pedalling to the greatest advantage is much more slowly acquired than that of balancing, and usually involves months of practice. At first the cyclist is content to press down each pedal in turn with his foot. As the crank travels in a circle, this pressure is effective for rather less

Fig. 3.



than one-half of its revolution, as is the case with the connecting rod of a locomotive engine. But the human limb possesses a power in the ankle-joint of applying pressure through a considerably greater part of the crank's revolution, and of correspondingly increasing the efficiency of the cyclist's strength as a motive power. To effect this it is necessary to practise the art of following the rising pedal from about the middle of its rise with the toe, by bending the ankle upwards. This makes it unnecessary to raise the knee quite so high as would otherwise be done, and places the foot when near the top of the revolution in the position shown in No. 1, fig. 3. It is now possible to begin the effective stroke by pushing the pedal forward, and it will be found that the foot will not slip so long as the toe is properly raised. As the pedal continues its course the ankle-joint is unbent, and the foot assumes the horizontal position shown in No. 2, which is most effective for the downward thrust. Finally, as the bottom of the stroke is approached, the toe is depressed, as seen in No. 3, the knee being still slightly bent, and in this position the foot is able to draw the pedal backwards over its lowest position. This is perhaps the most difficult part of the stroke, as there is a tendency, by resting the foot on the pedal, to retard its rise and thus throw more work on the other foot, which is engaged in depressing the opposite pedal. This tendency should be carefully watched and corrected by the learner. It is necessary in practice to keep a slight pressure on the rising pedal in order to retain the foot in its proper position, but it should be the cyclist's aim gradually to reduce this to a minimum. By assiduous and careful practice, at a speed not too great to allow the entire motion of the foot to be watched and controlled, these actions ultimately become automatic, and are carried out without conscious attention on the part of the cyclist, who will then find his mastery of his machine greatly increased, and the difficulty at first experienced in ascending inclines, or travelling against the wind, correspondingly diminished.

We have said that no beginner should use a machine unprovided with a brake. The skilled cyclist has less need of this contrivance, because he governs the speed of his machine largely by "back-pedalling," which is the act of retarding the revolution of the pedals by pressing on them in turn as they rise. At first this action seems to produce but little effect, but continued practice will enable the cyclist to place almost his entire weight on the rising pedal, dexterously shifting it from one to another as they rise in turn. The retarding effect will then be found sufficient on all but the steepest inclines. For touring purposes, however, when the cyclist is not thoroughly acquainted with the roads he may have to traverse, the brake is almost a necessity, though it may only be used in an emergency.

As the cyclist becomes accustomed to his mount he will find the various motions, which at first required care and attention, become more and more unconscious. In turning, for instance, the mere act of facing in the direction he wishes to take will appear sufficient to direct the course of the cycle. In passing over rough ground he will instinctively rise on his pedals or distribute his weight by leaning forward on the handle-bar when necessary, so that neither wheel is exposed to undue concussion, and by nursing his mount in this way he will avoid breakages, and so materially lengthen its "life."

He should now be able to exercise his judgment in selecting a bicycle for his own use. This is practically impossible until the preliminary difficulties have been overcome, and the cyclist who purchases his mount at an earlier stage is obliged to rely on the advice of a more experienced friend. In selecting a machine the height of the seat-tube from crank-bracket to saddle-lug should be so proportioned to the rider's leg-reach that only a small portion of the saddle-pin requires to be drawn out of the tube to place the saddle in a comfortable position. Next the total weight of the machine has to be considered. This depends to a certain extent on the weight of the rider, and to a still greater extent on the work it is intended for. If intended for general use, touring, &c., in all weathers, it should be equipped with an efficient brake —preferably of the plunger type, and supplied with a pad or pads of soft rubber where it comes in contact with the wheel—fixed mud-guards to protect the rider and machine, and a gear-case to cover the chain and gear wheels. This contrivance not only increases the ease of propulsion, by protecting these parts from the action of mud and dust, but by reducing wear and tear, and making possible more effective lubrication of the working parts, it extends the "life" of the machine. A machine so equipped for a rider of average weight usually weighs upwards of 30 lbs., the less costly machines being generally the heaviest.

The question of gearing is one which sometimes perplexes beginners, because it is by no means clearly expressed in the technical language commonly used. When a machine is said to be "geared to" 60 or 65 inches, what is meant is that it will travel as far for one complete revolution of the pedal as one of the old type of ungeared bicycles having

a driving wheel of 60 or 65 inches diameter. The phrase is therefore a survival from a past stage in the evolution of the bicycle. The rule for calculating the gearing of a modern bicycle is as follows:—*Multiply the diameter of the driving wheel in inches by the number of teeth in the foremost gear-wheel, and divide the product by the number of teeth in the back gear-wheel.* For example, if the driving-wheel measures 28" in diameter, the gear-wheel on crank-axle has 22 teeth, and that on the rear hub has 9, then $\frac{28 \times 22}{9} = 68\frac{4}{9}$ and the machine is said to be geared to $68\frac{1}{2}$ inches.

In selecting the gear of a machine, it is desirable to bear in mind that the amount of work done in propelling a bicycle one mile at a given speed, and under identical conditions, is the same whether the gearing is high or low. If high, a smaller number of strokes is necessary to cover the distance, but these must be more forcible; if low, less force is required, but a greater number of strokes must be taken.

It is therefore necessary to consider, in this connection, the age and activity of the rider, the pace at which he prefers to travel, and the nature of the roads over which this pace is to be maintained. Where the country is hilly, or the roads rough or muddy, a high pace cannot be long maintained without fatigue, consequently the pedalling with a moderately low gear will not be so rapid as to affect the breathing or the heart's action, and relief will be experienced by the reduced effort required for each stroke. Similarly with the young and active it will be found better to have a fairly rapid pedal action, rather than risk injurious strains by the heavy pushing required for a high gear. On the other hand, a less nimble but powerfully built rider, travelling on fairly level roads, will find it a distinct relief to reduce his speed of pedalling, while increasing the force of each stroke, by using a h gher gear. For touring, as the condition of roads and weather cannot be foreseen, it is better that the gear should be well within the strength of the rider.

The type of saddle selected will also depend on the weight and activity of the rider. A light saddle with little spring may suit the light and active, or those who habitually place a considerable portion of their weight on the pedals. Those who prefer to sit upright and rest mainly on the saddle will find the pattern in which a leather seat, stretched on a metal frame, is supported by helical springs the most comfortable, provided the springs are strong enough. For male riders, the saddle should be long, so that there may be no tendency to sit on the metal attachments, narrow in the peak to avoid interfering with the motion of the legs in pedalling, and sufficiently broad at the back to afford a comfortable support. The tension of the leather should be capable of being altered as required, by some simple means, and a good opening should be cut in the centre of the leather to prevent the formation of a longitudinal ridge.

Two kinds of pedals are in general use, the rat-trap, in which the foot rests on two parallel serrated steel bars, which, if the sole of the shoe is sufficiently flexible, afford an excellent hold to the foot, and are generally adopted for light machines. In the other type these bars are replaced by india-rubber cushions, supported by steel pins, which pass through them. Those more effectually intercept vibration, and are more comfortable for touring. The increased liability of the foot to slip can be largely obviated by the use of rubber soles to the shoes.

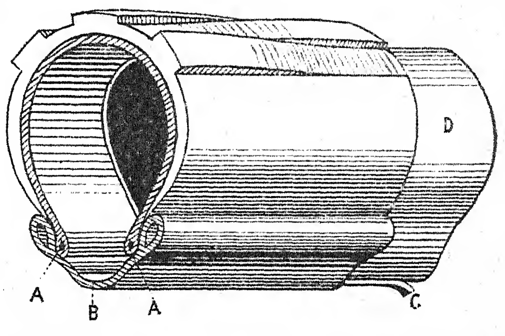
Pneumatic tyres have entirely displaced the solid rubber-tyres previously used, in virtue of their much greater elasticity, and the consequently diminished vibration and increased ease in driving the bicycle. It is well to note, however, that when in use they should always be sufficiently inflated to prevent the mere weight of the rider from materially altering the shape of the tyre where it touches the ground.

Those originally invented by Mr. J. B. Dunlop consisted of a single air-tube of rubber and canvas, surrounding the rim of each wheel, which could be inflated by means of an air-pump through a valve projecting inward through the rim. It was found that these tyres were liable to puncture by thorns, &c., and that repairs were somewhat difficult, and often were not durable. The tyre has therefore been divided into two portions, an elastic inner air tube, inflated as before through a valve, and an inextensible outer cover made of a woven fabric covered with india-rubber, which is generally corrugated on the outer side to diminish the risk of slipping in mud. In various makes of tyre this cover is secured to the rim of the wheel in different ways, but the principle of the invention consists in the fact that it is removable at will, so that the inner tube when injured can be repaired, and the patch effectually protected by replacing the outer cover.

In tyres of the Clincher type, the edges of the cover are turned outward, forming a ridge along each side. The edges of the rim of the wheel are turned inward to form a hook-like projection round each side of the rim. After the inner air-tube has been placed in position, the ridges of the cover are made to engage with these hooks, and the inner tube is then inflated. The pressure of the tube against the inner surface of the cover effectually prevents it from slipping from its attachment. It is necessary to see that the cover is properly hooked to the rim all round before fully inflating the air-tube, as the latter might burst if unsupported at any point. Whenever the inner air-tube is emptied of air, the edges of the cover can be pinched together and thereby freed from the rim. It can then be lifted off and the inner tube thus exposed.

In tyres of the Dunlop-Welch pattern, each edge of the cover contains an endless wire A A, somewhat smaller in circumference than the outer edges of the rim on which they fit. The centre of this rim (of which a section is given in fig. 4) contains a depression or groove B of considerably smaller cir-

Fig. 4.



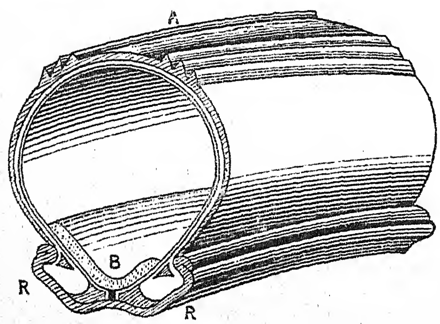
cumference than the edges, in which lies a stretched tape C covering the ends of the spokes. When the air-tube D is inflated, this groove is entirely filled by it, and the wires are locked by being forced against the edges of the rim. When the air is withdrawn, however, one of the wires can be pushed into the groove for one half of the circumference, whereby the other half of the wire is so slackened that it can be drawn over the rim and the cover thus removed. The inflating valve must first be loosened from the rim and pushed inwards.

Puncture Repair.—If a puncture has occurred, it is best to feel round the inner surface of the cover, as very often the thorn which caused it is still to be found there. This should of course be removed, but its position will indicate on what part of the air-tube the puncture is to be found. By stretching the tube a little it will generally be seen as a dark speck on the white surface. In that case the repair is very simple. By rubbing the tube with a piece of glass paper, the white coating around the puncture is removed, and some india-rubber solution from one of the collapsible tubes supplied for the purpose is spread, not too thickly, around the puncture. A piece of patching-rubber is also covered with solution, and after the solution on both has become very nearly dry, the two coated surfaces are brought into contact and firmly pressed together, when they will adhere without difficulty. A little French chalk is then rubbed over the outside of the patch to prevent adhesion to the cover, which can now be replaced by slipping the wire back over the rim, with due care not to pinch the air-tube in the process. When it has been ascertained that no part of the wire is resting on the air-tube and the valve is carefully replaced, the tube can be

inflated, and the tyre will be practically as sound as ever. In some cases, however, it is by no means easy to find the position of a small puncture, and it may then be necessary to remove the wheel from the bicycle, take off the air-tube entirely, first removing the valve which attaches it to the rim, and afterwards attaching this again to the tube. The tube should now be inflated, not very hard, but sufficiently to restore its circular shape, and passed foot by foot through some clear water, each portion being pressed and stretched with the hands when under the water. The escape of air-bells will indicate the position of the puncture or punctures, which should be marked with pencil on the tube, and the latter well dried. The repair can then be carried out as above described. Attempts have recently been made to diminish the trouble caused by puncture, by the introduction into the inner tube of a viscous solution, sometimes produced by dissolving sugar to a thick syrup, which being forced by the air into the smallest punctures, is found to make them air-tight.

Another variety of pneumatic tyre, the Fleuss, dispenses with an inner tube entirely. This tyre consists of a cover A, fig. 5, which is locked to a hooked rim R R, by means of

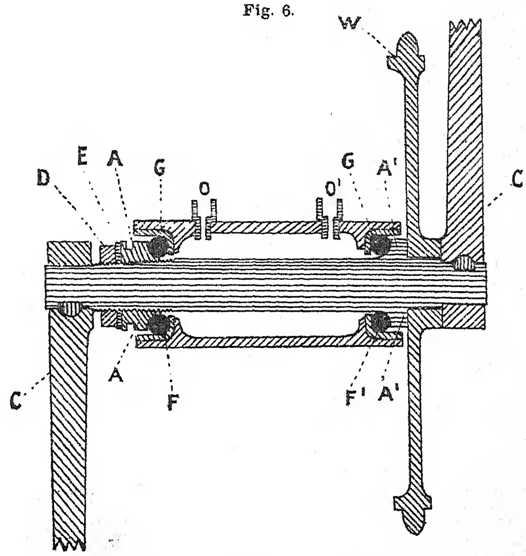
Fig. 5.



projections as in the case of the Clincher above described. But the space between the two edges of the cover is bridged by a tongue B of soft rubber, which is attached to one edge of the tyre and overlaps the other internally, the joint being made air-tight by the application of soft soap. In this way the tyre itself becomes a tube, and can be inflated through the valve in the usual way, the pressure of the air locking the external ridges into the rim. If punctured it is readily detached, and a patch can be placed on the inner side, where the pressure of the air on re-inflation tends to keep it in position.

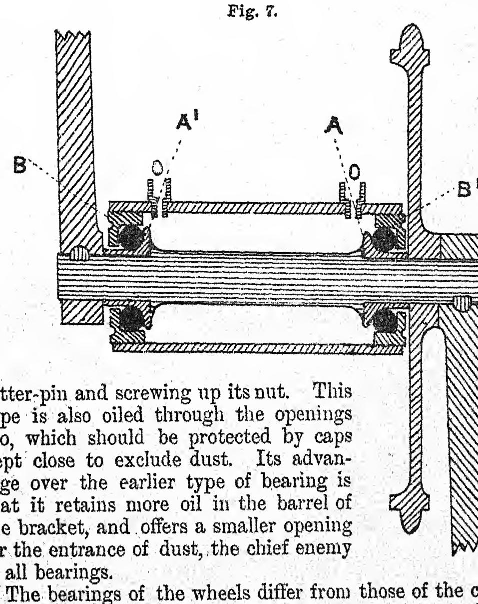
The *bearings* of a bicycle are the parts at which friction takes place. It is important to keep this as small as possible, which can only be effected by excellence of construction in the first place, and the constant care of the owner as to oiling, and the removal of dust and grit in the second. They are six in number; the crank-axle, the two wheel hubs, the two pedals, and the steering-head. The most important is that of the crank-axle, which receives through the cranks the full thrust of the cyclist's feet. Crank-axle bearings are of two types, the "cone-adjusting" and the "cup-adjusting," or barrel type, the first named being the older form. In it the crank-axle carries, besides the cranks C C, fig. 6, at each end and the toothed chain-wheel W, a pair of hardened steel cones, A A′ with their apices pointing towards each other. One of these cones, usually that on the left, is adjustable by screwing upon the axle, and when adjusted can be fixed in position by means of a locking nut D, separated from the cone by a washer E. The bracket has fixed in it two hardened steel cups F F′, placed between the cones and separated from them by a number of steel balls G G, which roll between the cones and cups, thus substituting rolling for sliding friction. The bearing is lubricated by introducing oil through the openings O O′, which finds its way along the axle and moistens the balls as they travel in their "races" or orbits. When the bearing becomes slack through wear, the nut D is loosened and the cone A screwed inward as far as it will go. It must then be unscrewed at least a quarter of a turn to provide sufficient play to ensure ease in working. The nut D can now be tightened and the bearing tested. If it appears at all stiff the nut should be again loosened, and the cone unscrewed until, when the nut has been re-tightened, the axle revolves with perfect freedom. In the cup-adjusting

Fig. 6.



type (fig. 7), the cones A A′ are both fixed immovably on the axle with their apices pointing outwards. The cups B B′, which face inwards, are screwed into the ends of the bracket, and secured in position either by pinching screws, or preferably by cotter-pins carrying screwed nuts on the ends to prevent them from shaking loose. When the bearing becomes slack one of these cotter-pins is loosened by unscrewing its nut and driving it back; the cup B is then screwed inward with a tool provided for the purpose until the slack has disappeared, and the bearing works with perfect freedom. The cup can now be fixed in its place by driving in the

Fig. 7.

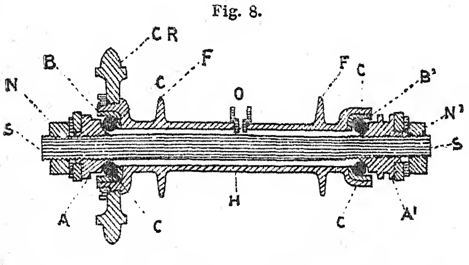


cotter-pin and screwing up its nut. This type is also oiled through the openings O O, which should be protected by caps kept close to exclude dust. Its advantage over the earlier type of bearing is that it retains more oil in the barrel of the bracket, and offers a smaller opening for the entrance of dust, the chief enemy of all bearings.

The bearings of the wheels differ from those of the crank-axle, because the central spindle is a fixture, while the barrel forming the hub of the wheel revolves round it. They are also made of the two types, "cone" and "cup-adjusting." Fig. 8 represents a rear-hub bearing of the former type. H is the barrel of the hub carrying the two fixed cups B B′ in its

ends. C R is the chain wheel, and F F the flanges to which the spokes are attached. The spindle S has screwed on it the steel cones A A′, of which one is fixed and the other adjustable. Between these and the cups B B′ are the balls C C C C. The spindle is held in the double fork formed by the lower back-stays proceeding from the bracket, and the upper backstays

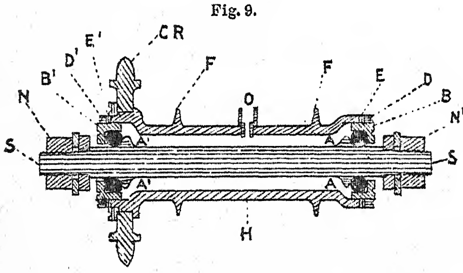
Fig. 8.



descending from the saddle-lug, by means of the screw nuts N N′, which also serve to lock the movable cone A′ in its place. When adjusting the bearings, only one of these nuts, N′, requires to be slackened. The cone A′ can then be turned either with the fingers by means of a milled edge, or with a spanner fitting upon it. The nut N should always be tightened up before testing the bearing, and the wheel should then spin with perfect freedom when held clear of the ground, but should not shake or show slack when the rim is pressed sideways. The opening for oiling is shown at O, and should always be covered to exclude dust.

A hub of the cup-adjusting type is shown in fig. 9, the same letters denoting similar parts. The cones A A′ are fixed

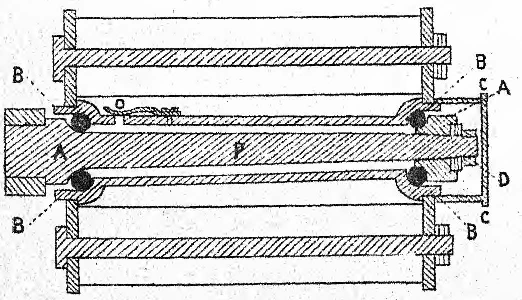
Fig. 9.



on the spindle, and the cups B B′ screwed into the ends of the hub, and then locked in position by the locking-rings D D′, separated from the hub by the washers E E′.

To adjust a hub of this type, one of the rings D is unscrewed a little way until the annular cup B can be screwed inward, generally by means of a pronged spanner fitting into holes in the outer face of the cup. When the wheel runs freely but without side-shake, the locking-ring D must be

Fig. 10.



carefully tightened up to prevent the cup working loose again. In some machines other locking contrivances are adopted. A hub of this type will retain a considerable quantity of oil, provided the cycle is not laid on its side, and therefore needs to be less often lubricated than the older type. The bearings of the front or steering wheel are the same as those of the driving wheel, except that the working parts are somewhat smaller. They are also made in each of the forms above described.

Pedal bearings are generally of the cone-adjusting type, the ball races being formed by cup-shaped recesses in the end plates of the pedal B B, fig. 10, and the cones A A carried by the central pedal pin P. The outer or adjustable cone is usually covered by a dustcap C C, which must be removed before the bearing is adjusted. A locking-nut D will be found on the outer end of the pin, which must be slackened before the cone can be screwed inward, and again tightened when the bearing has been adjusted. Pedals are generally oiled through a hole O in the tube which encases the pedal-pin. This hole should be always protected by a movable cap or spring clip, as this bearing is peculiarly liable to receive dust or mud from the feet.

The "head" of a bicycle is that part of the frame through which passes the "steering-post," a tube connected at its lower end with the crown of the fork holding the steering wheel, and at its upper with the handle-bar. This tube, which is turned by means of the handle-bar, moves on ball bearings placed at the two ends of the head. On the lower end of the steering-post there is generally a fixed cone directed upwards towards an annular cup in the lower end of the head, and between cup and cone are placed the balls. At the upper end of the head there is another cup facing upwards, and on the upper end of the steering post, a movable cone, often made in one piece with the clip which fastens the handle-bar. When this is the case, it is moved on the steering-post by a screwed ring above it, which can be turned with a suitable spanner. Before adjusting this bearing it is necessary to unscrew the nut which tightens the clip on the handle-bar. By turning the ring to the right, the upper cone can then be forced down upon the balls which lie between it and the upper cup. It ought to be adjusted without any shake, but must move quite freely, so that the front wheel will turn to either side by merely inclining the machine a little while pushing it. The nut on the clip-bolt must now be re-tightened, care being taken that the handle-bar remains at right angles to the plane of the front wheel. The steering is generally lubricated by means of an oil-hole in the head, through which oil can be introduced into the lower ball-race. When no such hole is provided, sufficient oil must be applied between the cone and cup of the upper ball-race, to allow a portion to descend inside the head and thus reach the lower balls. This bearing requires less frequent adjustment than any of the others, but it is essential to the perfect steering of the cycle that it should be kept in good order.

Chain Adjustment.—The chain should always have a little slack, in order that it may run freely. When the back wheel is held to prevent it turning, the pedal should be free to move from half an inch to an inch. Less slack is required on chains used in a gear-case. But if the chain through wear or otherwise becomes too slack, it may come off one of the gear-wheels and cause an accident. To re-adjust it, loosen the nuts at each end of the back-wheel spindle which hold that wheel in position, then tighten the small nuts placed at the extreme ends of the lower backstays, until the chain is found to be sufficiently tight—in the way above described. It is essential to do this by moving both these nuts equally, so that the rim of the wheel lies precisely in the middle of the fork formed by the lower backstays. This is most easily seen by turning the machine so that it stands reversed on its saddle and handle-bar. Unless the wheel is central the chain wheels will be out of line, and the driving will be difficult. Lastly, the large nuts holding the rear spindle in place must be thoroughly tightened again, as they have to withstand the pull of the chain in driving.

When it is suspected that any of the bearings of a cycle have become clogged with dust internally, they may be cleansed without taking them to pieces by filling an oiler with paraffin oil, and injecting it copiously through the oil-hole. The machine should be inclined to each side in succession, and the bearing spun until the liquid which at first flows from it in a dark or muddy state, appears perfectly clear. When the balls at each side have thus been cleansed, the bear-

ing must be well oiled with a thick lubricating oil before it is again put in use.

Where the brake passes through a small bracket attached to the fork-crown, it may need occasional oiling at this point to enable the brake spring to raise it from the wheel. The chain is another part which requires lubrication. The chief advantage of a gear-case is that it enables this to be done thoroughly, either by introducing a little oil into the case if it be oil-tight, or by covering the inner side of the chain with vaseline. By excluding the dust, the case preserves chain and gear wheels, while it materially lightens the driving. When no case is used, the chain may at intervals be taken off and well cleansed with paraffin oil, then soaked in lubricating oil, which must, however, be thoroughly wiped off the chain before it is replaced on the machine or it will attract dust. The chain can be removed by unscrewing and withdrawing a screw bolt which is provided for the purpose. In replacing it, both ends should be made to engage with the teeth of one of the gear wheels, which will hold them in position while the bolt is replaced.

It is sometimes necessary to remove pedals or cranks if damaged by a fall, as they cannot safely be straightened on the machine. If a pedal is held by a nut it is easily removed by unscrewing the nut. If by a cotter-pin, the nut on the pin should be unscrewed, the pedal or crank supported from the ground by a brick or block of metal, to prevent the bearings being injured, and the pin loosened by a smart tap with a hammer, care being taken not to injure the screw thread in the process. The same precaution must be observed when the pin is driven back into place.

In cleansing a cycle it is most essential to remove all dust or grit from the bearings, and from the neighbourhood of the oil holes, and to guard against water by any means getting into the bearings or the gear-case. In removing mud from the frame, many persons prefer to do so with a damp sponge while the mud is still wet. This is best for the enamel of the machine, but the minimum of water should be used, and none allowed to flow over the frame or near any bearing. As soon as the mud is removed, the whole should be very thoroughly dried with a soft clean duster. Other cyclists allow the mud to dry, and then remove it with a rag moistened with paraffin oil or kerosene. Of course the oil must be afterwards removed from the enamel. The plated parts of a machine when freed from mud or dust can be rubbed up with a slightly damp cloth, and afterwards polished with clean wash-leather. If a machine is to be laid aside for any length of time, those parts should be covered with a coating of vaseline, as the plating alone is not a sufficient protection from rust. The bearings should all be well oiled, and the heads of the spokes vaselined where they pass through the hub-flange.

Road riding.—When the cyclist begins to use his mount on the roads, he should make himself acquainted with the rules which govern vehicular traffic as well as those specially relating to cycles.

Thus it is the invariable rule in Great Britain, that in *meeting* any horse or vehicle, the cyclist must keep to his own left, while in *overtaking* one he must pass on the right side. The sole exception to this is in the case of led cattle or horses, when the cyclist should keep to the same side as the person in charge of the animal, as this allows it to be kept under better control. On overtaking any pedestrian on the roadway, the cyclist is obliged by law to give "audible warning" of his approach. This is usually done by ringing a bell carried on the handle-bar for the purpose. Such warning is not required in meeting a pedestrian, as he can then see the cycle, or on overtaking a pedestrian who is on a separate footpath. It is very unwise to ring the bell when close to any foot-passenger, as by startling him it tends to cause sudden movements, and may thus bring about a collision. By ringing at a fair distance, sufficient warning is given and no such risk is incurred. Between one hour after sunset and one hour before sunrise, every cyclist is obliged by law to carry a lamp which shows a white light in the direction in which he is travelling. Most lamps show coloured lights at the sides also, for the greater security of the cyclist amid traffic. As the motion of the machine considerably increases the draught, the lamp wick should be turned up a good deal higher before starting than it is when burning well at rest. Lubricating oil is not as a rule suitable for lamps. Special oils are sold for the purpose, in default of which ordinary colza is generally used, sometimes with a small addition of paraffin oil. Lamps require to be mounted on a spring to prevent their being shaken out by the vibration of the cycle.

For short distances ordinary clothing may be worn, but if riding at considerable speed or touring is intended, it is important that only woollen materials should be used, as thereby the danger of chills after being heated by exertion is reduced to a minimum. A large waterproof cape is often used to protect the shoulders, &c. It should be shaped so as to reach over the handle-bar and protect the arms. Shoes are preferable to boots, as giving more freedom to the feet; and knickerbockers or knee-breeches to trousers, for the same reason. It is desirable when going any distance to carry an air-pump and tyre-repair outfit in case of accident to the pneumatic tyres, which might make the machine unridable. An oiler containing oil, and an adjustable spanner should also be carried.

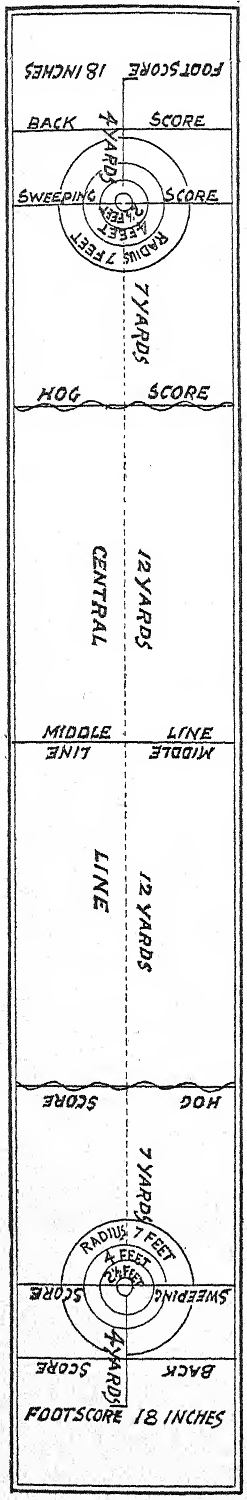
As regards speed and mileage per day, these depend so much on the vigour and skill of the cyclist, and on the nature of the roads and of the weather encountered, that no general directions can be given, beyond a caution against attempting, without careful preparation and practice, the utmost that his strength will permit. Ill-judged efforts can only injure the health without affording pleasure to the cyclist. It is scarcely necessary to point out that heavy meals should not be taken either immediately before or while riding. In touring, the diet should be carefully regulated. By due attention to these points, this form of exercise will be rendered not only enjoyable, but one of the most beneficial to the general health.

CHAPTER XIV.

CURLING.

Curling is a game which brings into active play both art and heart. The most simple may engage in it, and the ingenuity of the most scientific may be exercised at it. Skill and chance combine to heighten the interest of this excellent winter sport. In its general arrangements curling very much resembles bowling. Ice is a main requirement. That formed on the surface of a not over-deep pond, lake, or loch, is by far the best. Many clubs have special ponds constructed for their own use, and *glaceria* or artificial ice-rinks can now be made, on which curling lessons can be taken and fair amusement may be had. Even when no natural sheet of ice can be had, some low-lying field or park may be utilized by paddling and embanking, and made available for play. According to the "Rules of the Game" established by the Royal Caledonian Curling Club—the legislative body and general referee on all subjects relating to this winter sport—the expanse of ice on which a match is to be played is called a rink. The length of a rink "shall be 42 yards" (and in no case less than 32 yards), and its breadth ought to be at least 8 or 9 feet—*i.e.*, 4½ feet on each side of the central line; and this space is to be swept and kept *clear* ice. On this field of play a *diagram* is to be drawn (see annexed figure) previous to commencing, and is to be referred to throughout any game as *the rink*. In this the *tees* are to be set down 38 yards apart. Round each tee a circle of 7 feet radius shall be drawn, and for facilitating measurements minor circles of 2 feet and 4 feet respectively may be laid down. These concentric circles are commonly named broughs—enclosing lines. From a distance of 4 feet behind each tee, and passing exactly through them, a "central line" shall be drawn. Across each end of that central line, a line 18 inches in length shall be drawn at right angles to it, on which, at a distance of 6 inches from the central line, the heel of the crampit shall be placed. The *hack* in that position shall be 3 inches from the central line, and not more than 12 inches in length. As will be seen on referring to the diagram, the following lines also require to be drawn at right angles across the central line—

viz. (1) the *hogscore*, at one-sixth of the entire length for play; (2) the *sweeping score*, right across the tees for the use of the skips; (3) the *middle score*, midway between them; (4) the *back score*, just outside and behind the 7-foot circle.

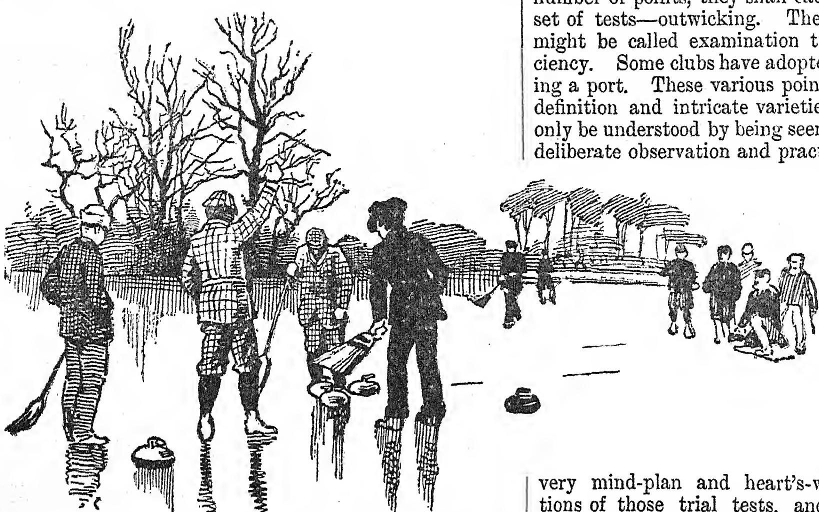


Crampits, pieces of iron, formerly in use, made to fit the sole of the boot or shoe, and having small spikes in them to safeguard the player's footing on the ice; but these are now generally dispensed with, and a foot-iron or tray, on which the player may "fit his tee" when about to deliver his stone, is now under this name placed near the end of the central line. A tee-ringer, by which the broughs—*i.e.*, the 2, 4, and 7 feet circles—and even the *hogscore* or *colly*, may be readily and accurately drawn, has been found useful. A tape is required for measuring the fixed and relative distances of the various *scores* and doubtful or disputable shots; but in many clubs a pair of compasses, one leg of which is shod with iron for insertion in the tee, while the other perambulates from stone to stone to touch the edges of those lying nearest the tee, is now used for the latter purpose. The curler's personal kit or outfit for taking part in a bonspeil consists of at least a pair of channel stanes; many take with them a double supply. In case of accident or need "they come in handy." These are generally carried in a strong, plain or lined basket, but curlers' bags are also in common use, as they are more easily carried, and afford better protection to the contents. Every curler brings a besom of sprigs of broom, or some substitute for broom, for "sweeping" and "coaxing up" are very important elements in "the roaring game." A piece of chalk is also a useful addition to the curler's kit.

The stones used are now no longer the water-worn stones, boulders, kernels, &c., picked from the stream or the débris of the water-beck, similar in size and shape, if smooth on the under side, from which they took the technical name of "channel stanes." They are now carefully prepared from special kinds of stone—Crawfordjohns, Burnock-water, Grey or Red Ailsa, and several others—blocked in the quarry, ground by machinery, weighed with accuracy, balanced with skill, made true and manageable on one side for keen ice, and on the other for ice which is dull, soft, or slushy. On each side a hollow is scooped out. The edge of this hollow forms a ring—on the keen side $2\frac{1}{2}$ inches, and on the other side $3\frac{1}{2}$ inches in diameter—on which the stone travels. In some stones the sides are so curved that they run on a pivot. The stones are polished, glossy, brilliant, and are furnished with handles, by which they are held till they are made to spin off with such degree of strength or skill as the player is capable or desirous of applying. These handles may be "swan" or "goose"-necked, in brass, nickel, silver, or other metal, according to taste, purse, and convenience, and usually bear the owner's initials, monogram, or name for ready identification. No stone shall be of greater weight (including handle) than 50 lbs. imperial, nor of greater circumference than 36 inches, or less height than one-eighth of its greatest circumference.

The rings being duly diagramed, the tees fixed, the ice clean and keen, the sides arranged, the skips chosen, the order of play arranged, the stones at hand and well conditioned, play begins. A rink consists of four players on each side. The *skips* or captains of each team arrange the order of the players, and, as the leaders, they have the right to play first or last on their own side as each chooses. Many elect to play last, as giving greater control over the result of the game. The rival skips settle between them which side shall lead at the first head or end. The winning party at any end leads off at the next one. The sweeping of the *howe* or keen ice of the rink is under the direction and control of the skips. The sweeping shall always be from central line to side, and the players may be called upon by their respective skips to sweep and clean the whole rink at the close of any head. Both skips have equal rights as to cleaning—sweeping and cleaning the ice behind the tee; but neither may do so when the other is directing any player on his own side. Skips alone may stand within the seven-foot circle. During the course of the playing of each end, those engaged in the game must be arranged along the sides, but well off the rink, as the skips may direct; and no person, unless when sweeping according to rule, shall go upon or cross the rink under any pretence whatever. The skip of the side engaged in playing at any particular time has choice of the place in front of the tee, whence he shall give his directions, and is not to be obstructed by the other while doing so. Anything tending to disturb the board-head during the playing of an end is strictly prohibited, except in the fair course of play. It is usual for the skip on each side to stand at the tee, broom in hand, to advise his players what they should try to do, and to point out how it may be done. Should any player deliver his granite weakly, he may direct his associates to sweep the ice before it with their broom besoms by the cry of "Lads, lay on your cowies now!" in favour of its progress, by giving it a smoother course. The technical terms employed—*e.g.*, "*draw* a shot here," "lay a *guard* there," "fill this *port*," "take this inring bonnily," "whip off this guard," "redd the ice," "a wee glibber and ye'll just sit on the tee," "that's a kittle shot, but you can do it," "set them rip-rappin wi' a rush," with varying emphasis—encourage and direct the players, excite the bystanders, and enliven the game. One team of four plays against the other. Each member of the rink plays two shots towards each end, in an order agreed on before beginning, and unalterable thereafter during the progress of the game. Each plays one stone alternately with another holding the same rank in the opposing team, thus:—Leader A, then leader B, 2 A and 2 B, 3 A and 3 B, and skip A, then skip B. The aim of each player is so to "deliver" each stone in his own turn, that it may (1) lie near the tee, or (2) clear a pathway towards the tee for some subsequent player on his side—by driving any of the stones of his opponents from a favourable place near the tee. Each player must put the heel of one foot at least in the back of the crampit. Then taking the stone in hand and poising it nicely, he swings it backward, brings it down cannily, soles it, all instinct with his tact and power, and sends it off scudding along the howe of the rink, while not only his gaze but often his body follows the missile, as if his very life were yet in it, while it snooves onward to the tee. Each subsequent player also strives to so ply his "channel stane" towards the tee that it, despising bunkers and obstructing stones, may, if possible, enter the house or home, as the outer circle drawn round each tee is technically called, or if not, that it may take a place as advantageous for his own side and as unfavourable

for his opponents as may be. Should any stone, which has not struck another stone lying in position, fail to cross the hogscore at the other end of the rink, or should pass beyond the seven-foot circle of the opposite house so far that a tangent line touching the most distant part of the circumference of that circle shows it to be outwith that circle, it is removed



from the ice, and counts as nothing in the game. The same penalty falls upon any stone which passes the back score, or on its way touches the swept snow on either side of the rink. When all the members of both teams have completed their respective throws, one end is closed and the score for it is made up. Each side scores as many points as there are stones played by them lying nearer to the tee than any of the stones belonging to the rival team. The winning side begins the next end, and the play proceeds as before.

The following incidents, which may occur in the course of an end or a match, require particular note :—Every player must be ready to play when his turn comes, and should do so without any unnecessary delay. If anyone plays (1) out of his turn, the stone he has played may be stopped and returned to be played in its proper order; but if, (2) before the mistake has been discovered, the stone has struck another or has come to rest, the skip of the rival players may either allow the game to go on, add one to his score, or declare the end null and void. If, however, (3) any other stone has been played before the mistake has been noticed, the game must go on and be finished as if nothing wrong had occurred. Should any one (4) play with a stone not his own, it may be stopped while running, but if not stopped in course the stone which he ought to have played may be placed where the other came to rest, to the satisfaction of the opposing skip. No player is allowed to change a stone or the side of a stone on which he has been playing after a match has begun or while it lasts, except by consent of the contesting side. No player may "deliver" a stone until that of his predecessor has ceased its running.

During the course of play skill and luck mutually combine to complicate results and give frequent occasion for applying the dexterity acquired in the past to the immediate practical problem of the moment. The main points to be taken into consideration are—(1) the nature and quality of the ice, (2) the best place to aim for, (3) the force and direction to be given to the stone that it may reach the desired place, (4) the positions of the stones, if any, to or through which your granite must pass, (5) the difficulties to be avoided in accomplishing your aim, (6) the results that may accompany or follow success, and (7) inferring from the comparative skill of the succeeding player how to improve the position you seek to secure, or nullify his probable play.

Ordinary games are generally fixed by agreement to be played for (1) a certain number of heads or ends; (2) winning a special number of points—*e.g.* 21; (3) the highest number of points gained (*a*) in a fixed number of shots, or (*b*) in a stated time—*e.g.* two or three hours. In competition (point game) matches, each competitor must play *four* shots at each of the *eight* following points—(1) striking, (2) inwicking, (3) drawing, (4) guarding, (5) chap and lie, (6) wick and turn in, (7) raising, (8) chipping the winner. This done, if two or more contestants have gained the same number of points, they shall each play four shots at an extra set of tests—outwicking. These are skill-testing, and what might be called examination trials of competency and efficiency. Some clubs have adopted an additional point—drawing a port. These various points are the subject of accurate definition and intricate varieties of arrangement which can only be understood by being seen and managed by careful and deliberate observation and practice, and, like chess problems, require the finesse and craft of proficients in the subtle and felicitous mysteries of curling — that seeing which results in science, and that incommunicable secret into which no initiation is possible—not an ingenious knack or deft tact only, but a sure and swift-minded union of will and skill, which seems to enliven the stone with the very mind-plan and heart's-wish of the player. Definitions of those trial tests, and specimens of the possible problems which arise from them, are given in the "Curling Club Annual," but they are best studied under the teaching of the "lads of the besom and stane," on "frozen water firm and true."

CHAPTER XV.

SKATING.

In skating the preliminary elements of study are, (1) "to keep the balance true," (2) to maintain the upright posture, by changes in the position of the feet, and by attention to the movements and inclinations of the parts of the body. The proper practice of either tends to impart a fine, pliant, yet strong action to the ankle, and a free, lithe, surefooted, quiet, and graceful carriage to the entire body as a habit. The intending debutant in skating should, a good while prior to the ice season, get hold of a pair of skates. They had better be old than new, and even if they are rather rusty, it will not matter much. These he should learn to put on and off, to fasten and unfasten, and get to feel easy about the ankle in thong, strap, or buckle. Next let him, in a room, on an uncarpeted floor, in a solidly paved courtyard, or on a firmly made roadway, don, and, having fastened his skates, proceed to stand and balance himself on the steel keel of the skates, first with both feet parallel, and afterwards on one foot and then on the other. This having become easy, he ought to walk about on the skates, so as to accustom his ankles to keep firm and steady under the body's weight upon the narrow footing of the upright blade. These exercises will enable him partially to overcome the early difficulties of dressing the feet and balancing the body. It will also prepare his muscles and tendons for work on the ice. He will have overcome some of the timidity almost inseparable from leaving *terra firma* for the glass-like stretch of ice. In some cases nervous persons, apprehensive of a fall, may feel the need of steadying help. The most kindly and effective form in which this can be given, is that some friendly person should place his open palm under the elbow of the beginner, not to support but to steady him, by the confidence sympathy induces. Having got on the ice, with his skates on, the learner may deliberately undertake a little drill:—(1) Stand steadily with both feet close together; (2) lean the weight of the body lightly on one foot and raise the other just off the surface for a second or two, and repeat this several times, changing the feet of course; (3) lay the right foot down, somewhat apart from the left. These exercises will enable

you to feel that while standing thus, your body's weight rests on the *inside* edge of the left foot. Next, when, the left leg being kept stiff, you lift the right foot and cross it over the left one so as to stand cross-legged, you are on the *outside* edge; you will see at once that the easiest and the safest edge is the *inside* one; for if you do overbalance, it

Outside Edge Forward.

will be on the side where the other leg may be used to prevent a fall. This practice of pose and poise may seem, to the impatient, slow. He knows the difference between *inside* and *outside* edges of course—why should he be hindered from starting off at once and doing something? He most likely requires to realize the difference, and he had better not be rash. To "hurry slowly" is wise. It is time enough to do things with a dash when you know how. All ordinary skating is done on the *inside* edge. Experience has taught that it is safest to do so. Unless you think "experience personally bought" is preferable, begin in a wise and safe fashion. Having got ready and feeling your nerves steady,

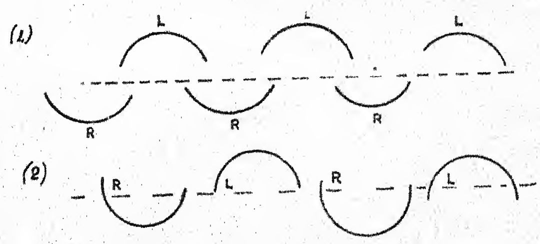
Outside Edge Backward.

move about upon the ice a little. You will by so doing make sure that your skates are trustworthily fastened and comfortable, and get used to having them on your feet. Familiarity and confidence being thus gained, dismiss fear. Raise the left foot—this will give just the inclination needed to bring the required pressure on the inside edge of the right-foot skate, and then make a stroke of about a yard with the right foot. The pressure should be made most heavily with the ball of the big-toe of the foot used, and be aided, at the same time, by leaning a little forward. To stand rigidly erect or to throw the head backward is to invite a fall. The most important point to be regarded is to keep the body within the line of gravity—so long as that is done the skater is safe. He has to get used (1) to balance his body on the single limb, (2) to preserve that balance when the shove-off is made, and (3) to maintain his equipoise while in motion—but practice will soon endue him with power. A novice will naturally feel inclined, as in walking, to advance the unemployed limb before the other. This is not to be done.

Inside Edge Forward.

He is to bring it on parallel with the other, and after finishing the first stroke, using it as a momentary prop, make a fresh stroke—habituating himself as he proceeds, not so much to bear his body onward *on* his foot as by the regulated movements of his body to control the motion of his foot. Having made sure that he can on one foot manage a stroke steadily from shove-off to strike or finish, he should proceed to train the other foot till he can, on it also, by the careful though pliant pose of the body upon the limb which carries it, make an efficient stroke. Take, then, to making each stroke with an alternate foot, being careful now to bring the foot used for the shove-off of the stroke parallel to the foot in motion when at the strike so as to be ready to make its stroke neat. On observing the progress made in the first six or eight strokes, he will find that the stroke made by each foot has really resulted not in a straight line but a curve—the curve made by the right foot tending towards the left $\overset{a\,b}{\smile}$, and that of the left towards the right $\overset{\frown}{a\,b}$ (fig. 1). Having satisfied himself of this fact, he will also find that his movements have been made on the inside edge. This is the most simple of lessons in skating on ice. The curve formed by one foot-stroke properly taken should describe about a quarter of a circle, and the skater should rejoice when with

Fig. 1.



foot after foot, in succession, he can manage easily several quarter circles. When he can with ease and comfort skim along, on the inside edge, with strokes that make a segment of a circle, like the inner curve of a crescent moon he has done well. The skater's next endeavour should be to take a few alternate strokes so as to gain an impetus, and then set off to do a complete curve, as nearly amounting to a circle as he can. This is done by getting the body duly poised on one limb—in general preferably the right—then with the body not full front but inclined sideways, with the right shoulder towards the front, and the left foot held behind at a right angle to the moving foot, with the toe (ready for use as a prop) nearer the ice than the heel—take the shove-off and speed on, straightening the knee of the moving limb as you proceed. This having resulted in going, as nearly as possible, "full circle," exercise the left limb in a similar manner—the left shoulder having the frontal incline and the right foot being carried behind, serviceably, in the same way as the left had previously been, and proceeding with the circle in converse courses, from left to right, as the other had been from right to left. Then, alternate these exercises, till the curvilinear becomes satisfactorily circular. In doing so he should look straight before him, but at each fresh foot-stroke turn out his toes, alternately to the right and left, till he can manage at will (1) a semicircle, (2) a full circle, and having continued his practice till these are quite easy, let him brace himself up for a stronger effort and complete "the circular route" successively (1) on one leg and (2) on the other, making the circles as nearly alike as possible in round of curve and size of rim. If one limb is less easily managed than the other give it more exercise, till both become as nearly as possible equal in power and deftness. Strike out one foot after another; bring the feet together occasionally as good companions, and then off again, curving your way in crescent, semicircle, and circle; thereafter two circles consecutively, adjoining each other, making a double circle, the figure 8. Avoid, however, looking to the feet, let your eyes rather be raised, accomplish a circular movement by the impulse given and the muscular action taken. At first you most likely may not perfectly work your strokes into one another, or join your circles closely together without making the one intersect the other, but if you make your circular sweep large and gradually diminish the area circumscribed you will soon succeed. The scientific figure 8, however, requires a knowledge of skating on the outside edge, *i.e.*, on the outer edge of the skate on either foot. In skating on the inside edge, the line of gravity is easily preserved, for it lies within the body's space. In using the outside edge we throw the chief weight of the body beyond the line of gravity which rises perpendicularly from the edge of the skate in use. This involves quite a different pose of the body in relation to the position of the feet, one which rarely occurs in athletic exercises. The knee of the leg in use must be kept straight, the body erect, the shoulders somewhat inclined forward, the upper limbs quiet, and the muscles of the lower portion of the body under thorough control, the head up and the eyes straight forward. The unemployed foot must not precede the skating one, but be kept with the heel near the foot on the ice, and the toes turned out well from it. The lean of the body beyond the perpendicular of gravity on the one side is to be counterbalanced by the weight of the free limb on the other, and thus establish a fresh equipoise. Now, with the right foot skate make a bold firm stroke, such as may give a well-rounded curve. Practise till you can complete a full circle, fig. 2. When the force with which you have formed one circle is exhausted, but before you come quite to a stop, bring the left foot past the inside of the right—pressing first on the outer edge of the heel and then on the inner edge of that foot to steady you, while you cross the left foot over the right toe at an angle well pointed to the right, and place it down about 6 or 8 inches before the right foot. This done be ready to make a strong bold stroke with the left foot, and having at the same instant given a smart impetus with the inside of the right toe, and transferred the weight of the body to the left limb, while the poise is regulated by the right, complete a new circle, returning to the point where the legs were previously crossed. Fig. 3 shows the figure 8 done on the inside edge alone, proceeding from A to B, and returning to A, and recommencing at A, passing by C to A again; fig. 4, the figure 8 performed by proceeding with left foot from A

Fig. 2.

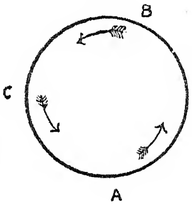


Fig. 3.

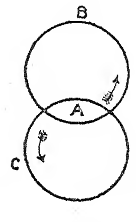
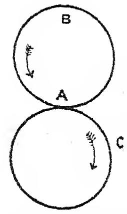


Fig. 4.

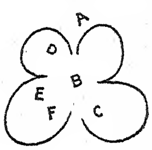


past B to A again, changing to the right foot at A, and by C returning to A, all being done on the outside edge.

Another stage of progress bears the technical name of *edges*. This is the tact acquired by practice of changing the mode of motion from outer to inner edge and *vice versa* without effort, change of foot, or speed. In this way splendid amusement may be taken, as the skater on one foot flits along the ice surface, keeping his balance and displaying his skill. The letter S may be formed and extended into a long serpentine evolution; Q may be formed by making a circle and adding two-thirds of an S. Semi-crescents and many other complimentary shapes and forms ingeniously varied, impart added charms to the active practice of the art of skating.

Next set yourself to study *turns*. A turn means a change of direction through the use of a half revolution. There are *four* simple turns on each foot—technically named threes, because they form when performed the figure 3 upon the ice-board (fig. 5). To skate an ordinary three—that is, a turn from the outside forward, beginning on the right foot, to the inside backwards—has been described in better and simpler terms than I have elsewhere seen by the Rev. G. Harford-Battersby, B.A., as follows :—

Fig. 5.



1. Stand very steadily, and, without a jerk, take a quiet stroke forward on the *outside* edge with the weight on the *toe* part of the skate.

2. Bring the left leg for a second to its position behind the right—so that the right side of the body is foremost.

3. Prepare for the turn by bringing the left leg, thigh, and whole side forward, but with the eyes to the right.

4. With a kind of hop let the foot make a quarter turn (on the *toe*, not, as in drill, on the heel), and at the *same* time look round to the left.

5. Travel backwards for a certain distance, keeping the left leg and left shoulder well back to the left, and with the eyes looking over the left shoulder.

Study the moves beforehand carefully, take the position as described, each over and over again so as to accustom the muscles to the actions, and then set yourself to interpret the instructions into actions. The home study will be all the more effectively accomplished if the learner has a pair of roller skates and knows how to use them.

The skilled skater can scud over the ice with speed of pace and grace of carriage; start swiftly, stop suddenly, career hither and thither in mazy evolutions, requiring him to turn and wind and dodge and make many curious figure movements on the ice. The details of these are intricate and difficult to describe, though when the elementary stages have been gone through, and the attitudes and motions necessary for the performance of the evolutions of *eight* and *three* in due variety and with practical skill, the further developments required to undertake double-threes, half-double threes, triple threes, the rose, the loop, the cross cut, the spread eagle, &c., become easy on being seen executed by an adept. Ease, comfort, grace, and enjoyment enrich the experiences of the skater, and inspirit his nature—dispelling the winter's cold, and warming with the glow of health and the gladness of sympathy the days spent in ice-sports.

Mr. J. M. Heathcote has suggested the following skater's decalogue—to be engraven on the tablets of his memory—boy or girl, and adhered to as man or woman.

1. Learn to put on and to take off your own skates.
2. Do not carry a stick, a muff, or anything else that will impede the use of the arms while skating [or may interfere with the comfort and progress of others].
3. Do not look down [any] more than is necessary to enable you to [see and] avoid cracks or any other obstacles you may encounter on the ice.
4. Concentrate your attention on the poise and sway of the body, rather than on the movements of the legs and feet.
5. Make the *side-thrust* with the whole length of the blade.
6. Do not make a *scratching thrust* from the toe, but keep the skate as near the ice as possible, after the thrust.
7. Keep the feet as near to one another as you can without constraint.
8. Remain as long as you can on the unemployed foot.
9. Avail yourself of every opportunity of following a good skater, keeping close behind him, and imitating each movement of his body, arms, and legs.
10. Never throw stones on to the surface of a sheet of ice on which you or any one else can possibly wish to skate.

CHAPTER XVI.

TOBOGGANING.

Tobogganing is a combination of sliding and sleighing. This manner of sliding down snowy or icy slopes with some sort of sledge-like conveyance supplies excellent exercise, healthy activity of respiration, and much enjoyment to those who love speed of movement in the open air. Though it began to be regarded as a fashionable winter pastime scarcely twenty years ago, it was a favourite out-door sport in Canada for many years previously—and indeed the idea of it was borrowed from the practical plan adopted by the Indian tribes in the northern latitudes of America for conveying provisions during the frosty season from hunting-ground or store to camp. The Canadians organized that into pastime which the Indians had invented as a necessity, and the amusement found in it as a social sport led to its speedy imitation in the United States. In reality, though the name is new, and the kind of vehicle now employed has been improved and made more comfortable and even luxurious, the recreative gaiety found in speeding down a snowy slope must have made this form of glissading a source of merriment wherever snow falls and Jack Frost invites to the deray of locomotion. For ourselves we remember spinning speedily down some of the slopes of the Southern Highlands—on what we called in horseman's Latin *tandem*, both in regard to time and line. Nor were we very nice about the *tandem;* a disused tea tray, an old box lid, or a window shutter lifted off its hinges * proved serviceable make-shifts, and, as we did not know how long the snow might lie, were speedily extemporized into a merry-making conveyance. At Earl's Court Exhibition (1887) we recognized our school-day's friend, rejuvenated, fashion-favoured, and titled in "the toboggan" gallery. The true toboggan, however, is a wooden-plank rest, about 5 feet in length, 11½ broad, formed as car-like as fancy inclines, set upon two runners of wood faced with iron, and turned up at the peak or prow like that of a sledge, only raised rather higher. This may be guided by trace-reins attached to each side of the prow, or "the adventurous setter-forth" may paddle-steer his course by the use of short sticks to direct his vehicle whither he wishes it to take its way. On such a conveyance, on a favourable declivity, a tobogganist has been known to rush along 700 yards in 20 seconds.

For this amusement we require (1) a good steep hill-slope with an even smooth surface; (2) a heavy snowfall; (3) a toboggan—of such sort as we may be able to get; (4) watchful eyes; (5) steady nerves; and (6) presence of mind—to the point of daring, but not of foolhardiness. If the snow is firmly textured, hard and smooth to admit of good going, and especially after it has been glazed and rendered slippery by being traversed a few times, the speed will be such as to please the most daring, and what with whiz of progress downhill, and the pulling up of the sledge at the end of each run, this winter sport affords a most thorough out-door exercise; and is particularly favourable for the full development of the lungs, and the freshening up of their air-cells.

Social tobogganing, however, as practised where snow abounds and may be relied upon for a long time, greatly enhances the fascination of the swift descent. It requires a larger and more elaborate vehicle. This is made of thin ash boards securely fastened together, turned up at the ends into almost a semicircle, with steel runners along the under part to increase its speed of progress. It may have side-rails for security or hand straps to hold on by, and when overlaid with cushions, and the tobogganers are snugly prepared for the weather, the run is very exhilarating. One of these machines 8 feet in length and 1½ in breadth, and standing from 6 to 8 inches high, accommodates four persons.

The Coaster or Swiss Toboggan is a simple wooden vehicle used by school children for descending the steep valley paths in the recesses of the Alps. But recently luxury has set

Tobogganing.

ingenuity on the alert, and elegant as well as comfortable machines have been invented. These have two wooden runners shod with steel, and turned up in the prow about half-a-foot, so as to form a segment of a circle. On these runners a light wooden bed-like framework is constructed, on which the tobogganist sits (not reclines), with his heels resting slightly against the bend of the prow, if he does not employ them, as many do, in directing the course of the machine. This, however, is frequently done by iron-pointed pegs or guiding sticks, about 18 inches long, held in either hand. Sometimes an adventurous runner will pillow his chest on the prow-bend, and keeping a good lookout pilot his snow canoe down a long slope, and even rounding the curves in his descent as he goes sounding on his perilous journey. The name now given to the Swiss toboggan or coaster is *Schlittli* (skater). The Bob-sled is made in three parts—(1) a long low rest on which the travellers may recline or sit; (2) a pair of long low runners under this sled-rest united by swivels to (3) a shorter pair of runners in front of this to be used in guiding the vehicle. The swivel movement gives great advantage in turning curves, or passing from side to side in the choice of the best portions of the pathway. These varieties are, however, intended for sport where the winters are long and the snow may be trusted to yield a good deal of opportunity for play. They are probably too expensive for use even in our Highlands for hiring,

* In Montafona, an out-of-the-way valley in Tyrol, horses' ribs are used as runners for a rude toboggan used by these mountaineers for traffic travel.

owing to the vicissitudes of snowfall and thaw to which in our climate we are liable. It may be just as well to mention that before venturing on a tandeming or tobogganing slope run, it is highly advisable to survey the proposed path, see to the position of the leaps, to the curves, and to the dangers of the roadside should the sledge go off or over, and, where necessary, to take measures against the likelihood of the runners *scrunching* upon stones, as well as to protect the course by a deep snow-dyke, and to fill up the hollows into which if one swept unawares an upset might be feared. With due caution and care no danger need be dreaded.

It may be regarded as a curious illustration of the saying "there is nothing new under the sun" to read in "The Description of the City of London," written 1170–1182, and edited in 1772 by Dr. Pegge, that "the children in London made use of the jawbones of a horse or a cow as a sort of sledge, and that when safely seated therein, taking in their hands poles shod with iron, which, at times, they strike upon the ice, they are carried along with as great rapidity as a bird flying, or a bolt discharged from a cross-bow."

CHAPTER XVII.

BOATING—ROWING AND SCULLING.

Even in the lowest stages of civilization men seem to have perceived and employed water as a means of conveyance of persons and goods, and have taken advantage of it for carrying purposes and for pleasure in rafts, boats, &c. Boats differ very considerably in form and build, according to the purposes they are designed to serve. Those intended for the conveyance of goods must be strongly constructed, and if to be used in shallow water require to be flat-bottomed. If designed for speed or pleasure they ought to be made light and slim, having fine lines, so that they may meet little resistance in their progress through the water.

Boating is now in ordinary speech most frequently employed to signify the management of a vessel set and kept in motion by hand-power; such are, *e.g.*, barge, canoe, gig, launch, outrigger, pinnace, skiff, or wherry. These are usually such as can be launched from and drawn up on a beach. That a boat may float, it must displace such a volume of water as shall equal its own weight when fully laden; but that it may float with safety, its centre of gravity (see vol. i., p. 117, col. 2) must be above that of the water displaced by it. The depth of the part of a boat's body immersed in the water should not be great. The depth of a rowing-boat in the water is called its draught, its height above the water its freeboard. It is the part below the water-line that is of importance. Depth is measured, on the outside, from the top of the gunwale (or upper beading which stiffens the sides of a boat) to the under side of the keel (if any). Those who desire to learn to row will find it safest and best to choose such wide and deep craft as will allow of a good deal of moving about in it without fear of a capsize. In such a boat, though your oars fail to catch the water, or you should "catch a crab," no danger to yourself or the boat is at all likely. Of course, in whatever kind of boating one may seek to attain proficiency, he must learn to look upon a wetting or a ducking as a trivial affair. It would be just as well that those who intend to engage in boating should have some practical acquaintance with the art of swimming (see Chap. III., p. x.)

Rowing affords excellent athletic exercise, and is a pleasant pastime. Although much information about the management of boats may be communicated in a book, only observation, experience, practice, and thorough work can ensure actual mastery and the safety combined with pleasure of rowing as a genuinely scientific athletic exercise. Almost the best, and especially the safest, way of learning to manage a boat is to go out, by choice, in a good, steady, heavy rowing-boat—if you keep clear of other vessels and near enough the bank or shore. Do not estimate the rowing worth of a boat by the lightness with which it may be lifted on the beach. The shape has really a good deal to do with the buoyancy of a vessel. It is a good thing to see how she behaves in the water. If she is trim, taut, and well balanced as to her strakes, she may be more easily rowed than one which is lighter. Begin, when possible, with one broad in the beam, having a good distance between water-line and sheer, as well as a straight keel. Breadth is favourable to stability; and depth, by affording greater resistance to the water, retards progress. Perhaps the best thing to do at first is to get acquainted with the different parts of the boat, and learn all you can about them. An open boat is one without water-tight decking, and which is not divided into compartments by partitions. The most lively form of build for an open small-boat is that called the *clincher* style, in which each plank overlaps the one below it, and each continuous strake or side-plank, from the uppermost gunwale plank to that which is rebatted into the keel, is clenched fast with rivets to the one next below it along its entire course. The overlapping edges of these strakes are called *lands*. A boat whose strakes do not thus overlap is said to be *carvel-built*. All its planks being flush one with another, the sides present a smooth surface. The whole part of an open boat immersed between keel and waterline is called the *floor*, and it is to be observed that the flatter the floor the more buoyant the boat is, the less likely is it to roll, and the more safely it will go through broken water. Over the floor, floor-boards are placed for comfort, to keep the feet free from the bilge water, and to cover the ballast. They are loose, so that they may be lifted when the boat is to be cleaned or the ballast, if any, is to be shifted.

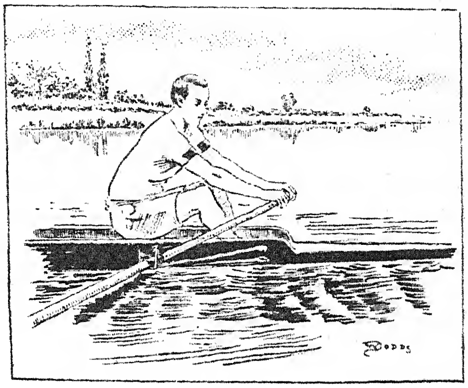
The *beam* is the breadth of a boat measured across from outside to outside; but *beams* are strong timbers fitted athwart—*i.e.*, between the sides of a vessel, and hence named *thwarts*. They are secured to the sides of the boat by knees fixed by a purline on the ribs; being strong and unyielding, they support the sides in position, while they serve as the cross-seats on which the rowers sit. They ought not to require props in the centre, as these hamper storage and are apt to be kicked out of place. The *bows* are the inward curves toward the *stem* or fore part of the boat. So much of a boat as projects forward of the head above the water-line is named the *prow*. The *bow-board* is a piece of wood, generally ornamented, placed behind the bow-seats. The *back-board* is a piece of wood similarly placed behind the back-seats. The *head sheets* denote the space of the boat to the fore of the *bow-thwart*. The bow-thwart is the seat occupied by the foremost or bow-oarsman. The *waist* is that portion of a boat's side-surface which lies between beam and *quarter*. Quarter is that part of the boat aft of the beam to the *stern*. The stern is the hinder portion of the vessel, and the *stern sheet* is the name given to the part aft of the *stroke-thwart* to the stern. Stroke is the hindmost oarsman, and occupies the stroke-thwart. Those seats which are occupied by others than the rowers are called *benches* when they are aft of the stroke-oar, and *side benches* when they are placed along the sides. For the lessening of weight, giving free circulation of air, and preventing the holding in of water, benches are very often made open in their woodwork, like garden-seats. That part of the boat on which it rests when aground is called the *bilge*. The deepest part of a boat, and that wherein bilge-water accumulates, is called the *well*. Every boat should carry a tin vessel as a bailer with which to empty the well when the bilge-water rises uncomfortably above the floor-boards or foot-waling battens which cover any ballast. Those movable pieces of wood against which the feet of the rowers are pressed for support are named *stretchers*, and the pieces of wood by which these are held in place *stretcher-guides*. If the boat is furnished with cushioned seats, they should be of a useful sort—not stuffed with rags, cotton, or wool, which absorb water, unless very carefully covered with trustworthy waterproofing. If made with cork they will be lighter, and may be serviceable as life-buoys.

The art of boating is a useful one, and is a favourite athletic pastime. This is especially the case with rowing—the use of oars or sculls in propelling a boat through the water. The boat is the *weight* to be moved; the water is the real, though the rowlock is the apparent *fulcrum* or rest; and the oar is the *lever;* while the hand is the *power* which, properly using the lever upon the fulcrum, causes the weight

of the boat (and its contents) to move. The oar is a long timber instrument intended to be used by a single person in rowing. It consists of several parts—(1) the *grip* or handle; (2) the *loom*, the in-boat part between the handle and the rowlock; (3) the *button*, a leather knob put on to keep the loom from going too far out through the rowlock; (4) the *leather*, a band of some sort, mostly of leather, to preserve the oar from wear from its action in the rowlock; (5) the *neck*, the out-boat part of the oar between the loom at the rowlock and the blade; and (6) the *blade*, the flat and slightly curved part which dips into the water. Rowlocks are iron or brass fittings of various patterns revolving on a pivot, fixed to the gunwale or to the outrigger if the boat is narrow. *Tholes* or thole-pins are upright pieces or pegs of wood, either fixed into the gunwale or movable from one hole to another, formed in the gunwale, and protected by brass rims. They are designed to steady and retain the oars in their place. The greater the distance of the oar-grip from the rowlocks (or tholes), and the less the safe distance of the water from the out-boat part of the oar in the rowlock, the greater the (possible) power of the rowing and the speed of the boat. The grip of the oar ought not to be round or smooth, but made to suit the grasp of the hand, or it will either roll in the fingers or slip from the hold, while the hands will very readily blister.

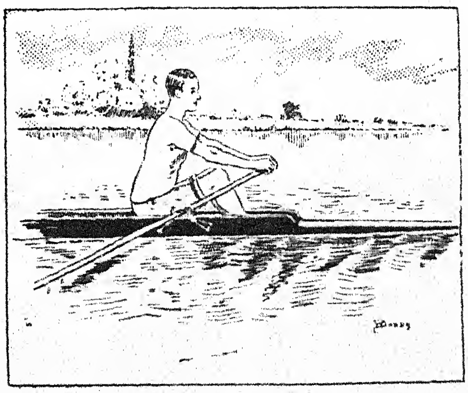
The conditions and opportunities essential to exercise and pastime being abundant, the attainment of the rudiments at least of the art and practice of managing a boat should have a very general charm. A steady boat and a steady friend are good things to begin with, and a few very simple cautions may help both friend and learner. In stepping into a boat do not place your feet on the gunwale or side seats, but step either into the bottom of the boat or upon the middle of the cross-seats (thwarts). When ladies are getting in, the boat should be held steady till they are properly seated. When pushing off, stand in the body, not by the bow or on the side seats. No more than one person ought—whether entering or leaving a boat, or shifting place in it—to stand up at the same time in a rowing boat. No unnecessary distraction of helmsman or oarsman should be indulged in; especially avoid sudden rising, cries, or change of place. Obey implicitly the directions and orders of the person into whose charge the boat has been placed. Remember that salt water rots leather, and therefore avoid wetting shoes or boots, and when boating wear canvas shoes having india-rubber soles. Do not put on clothes that are readily spoiled, and see that they are such as will allow the utmost freedom of limb. If in boating you get wet, do not, if it can be helped, let your clothes dry on you, but change them as quickly as possible—especially if damp with fresh water or rain. Port is the *left* and star-board the *right* hand side, looking from stern to bow.

A novice in rowing should study the art of handling the oar under the direction of an experienced oarsman, whose verbal directions are indispensable in learning to row well. A good oarsman will see that the thwart on which he sits is steady and of the proper height for him. Unless he sits so as to exercise complete control over oar and boat —in relation to the water—he cannot manage to employ that light, smart, and timely stroke which keeps the head up and sends it onward. He should sit well aft on the thwart, place his feet—heels close together—firmly on the stretcher, having his knees slightly bent, and about a foot apart from one another, and rising just so high that the oar while in motion comfortably clears the knees. When the rower has himself in position thus, he should grip his oar close to the end, with the hands about three inches apart, having the fingers above and the thumb under the part grasped. The two upper joints of the fingers should perform the grasp, the lower joints being left nearly straight, then the thumb should close and grip, but without compelling the lower joints of the other fingers to join in the grasp. The lower part of the palm and the ball of the thumb should not touch the oar at all. The oar being placed between the tholes or on the rowlock, with the blade just far enough dipped into the water to cover the blade, but no more, he is prepared to act. Set the shoulders square; expand the chest, that the lungs may have free play; keep the back straight, then having the oar properly in grip, stretch out the arms with muscles in readiness; incline the body forward, with spine straight from hip to head. See (or rather feel) that the oar has hold of the water, the blade being at right angles to its surface, and then, with a long, strong, equable pull, swing the body



The Grip.

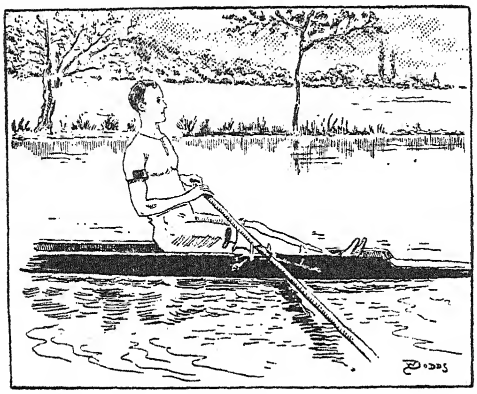
steadily back, bringing the elbows well in towards the sides, and the wrists within touch of the full-stretched chest, and finish the stroke with a finely feathered oar. To feather an oar is so to turn the blade immediately after it issues from the water as to bring it breadthwise into a horizontal position, that it may not catch the wind or skiff the water between stroke and stroke. This should be effected as follows:—At the conclusion of the stroke the base of the thumb is the portion of the hand which should first touch the chest. As soon as it does this the hands should be sharply dropped two or three inches, which will lift the oar-blade clear of the water still in a vertical position. Then, but not till the oar is clear of the water, the wrists should be lowered, causing the oar to revolve on its own axis through a quarter of a turn, which will bring the blade into a horizontal position. The next step is to get forward into the position in which to begin another stroke, which is called "recovery." First the arms are extended in front of the body as rapidly as possible, thus pushing the oar away from the rower, the blade of course retaining its horizontal position. Then the body should be swung forward steadily, with the arms now outstretched to their full length. The first part of the recovery should be the most rapid. As the end of the reach is approached the



Middle of Stroke.

speed of the swing forward should slacken so that it may end without a jerk. Just before the next stroke commences the wrists are straightened, which brings the oar-blade into the vertical position, and then the hands are raised sharply so as to immerse it edgewise just as the body commences to throw itself back. The next stroke then proceeds through the

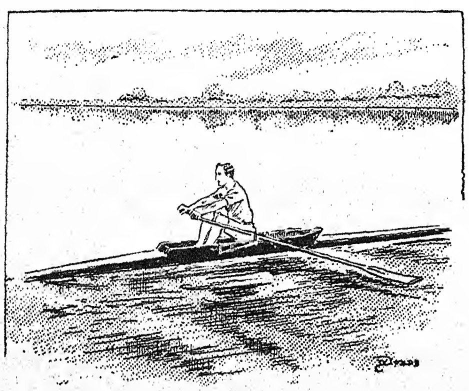
same cycle of movements. These should be practised separately as well as together under the eye of an experienced oarsman, able to detect and correct faults of form, until they become practically automatic. In racing boats the recovery is aided by straps attached to the stretchers, through which the feet pass, but the muscles of the body should do the greater part of the work, and such aids may not be advisable for learners. Some raise the oar considerably above, while



The Finish.

others allow it almost to skim over the surface of the water. The swing of the body in plying the oar ought to be in line with boat—straight from stem to stern, not towards either side. Following these directions deliberately, the accomplishment of making a perfect stroke will be surely acquired. This implies uniformity of work, equability of force, tension, and precision in time, and excludes shirking. By making a steady sustained stroke, a far larger distance is traversed in the same time with a much less expenditure of physical energy than can be gone over with much fatigue and loss of breath in ill-timed, intermittent exertion, varied by an occasional spurt. Avoid especially pulling from the elbows rather than the shoulders.

A scull is a light and small oar, the loom of which is in length equal to half the width of the boat to be impelled; so short that one man may work a pair. Oars and sculls ought for easy use to be somewhat elastic. The handles of sculls should overlap each other a little. Short looms are in general to be preferred to long ones—especially in boating



Feathering.

on the sea. When two or more persons each work a pair of oars it is called *double-sculling*.

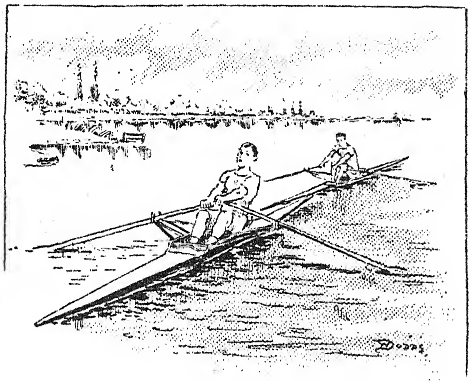
When one has become thoroughly master of the use of one oar, he may then begin to work a pair. The boat chosen for this ought to be light but safe—an ordinary skiff, but not an outrigger. The latter is too easily capsized by a false stroke, a swerve in the motion of the body, or an inequality in pressure on or speed of the oars. In using two oars sit exactly in the middle of the thwart. When oars or sculls overlap, the right-hand oar is that most frequently plied as topmost. Take care that the oars are dipped in the water without undue delay, and lifted from it cleanly and sharply at the end of the stroke; keep the head erect, look straight before you, watch your hands rather than your oars—if the hands do their duty the oars will act rightly. The following terms concerning oars will be found useful:—*Boat oars* signifies, lay them in the boat (having ceased rowing). *Lie on the oars*, suspend rowing for a time. *Ship oars*, fix them in the rowlocks ready for use. *Unship oars*, remove them from the rowlocks. *Easy all*, stop rowing. *Forward all*, stoop, ready to take a stroke when "go" is said. *Back her*, dip the blade well in the water and push the oar from instead of pulling it to you. *Time*, keep swing of stroke along with the stroke oar. *Paddle*, row slowly.

A boat starting from a seabeach should be kept upright on its keel, and run down on wetted pieces of hardwood called *skids*. On reaching the water-edge, point the head in the direction of the waves, put in any ballast required, shove off not on the big but on the small waves. The big waves generally run in threes, and then come the small ones. A short wait to see and seize the opportune start may save the shipping of a sea and getting a thorough wetting, or being tossed back broadside on the beach. Get into the boat by the stern, so that your weight may lift the head just as it floats off. It is much safer going *out* than coming *in* through a surfy sea; for danger is faced in the former case, in the latter it overtakes one from behind. In going in towards a beach, keep the stern and head end-on in the direction of the rolling of the waves; back stern against the big waves, and let them roll in, but row quickly and well with the small ones. They will float you longer and run you in more easily. In sea-rowing the strokes ought to be taken shorter and quicker than in river-rowing, and they may be best timed by the waves. Get a boat's head fairly aground before leaving it, otherwise, by bringing your weight forward the boat will be hindered from running up, and a broadside from the sea is risked. Keep to leeward head-on towards stream or tide when going alongside of a vessel or pier. In small craft do not keep too close to the bank of a river. Never in a rowing boat change helmsmen when near other vessels, and do not cease holding the tiller or yoke-lines until they are safely caught by the exchanger.

The *rudder* is the fitting by which a boat is steered and kept in any desired course. The management of it should only be intrusted to a trustworthy responsible person. He must take care that the rudder is properly hinged by the pintles into both the upper and lower gudgeons or rudder-irons; that it is securely supported, swings easily, and answers to yoke-lines or tiller. The *yoke* is a piece of wood into which the neck or stock of the rudder is fitted. It is pulled by yoke-lines to right or left as required. If the lines are held straight from each end of the yoke, that one is pulled which is in the direction, left or right, in which the boat is required to proceed. A tiller or helm-stock is the handle of wood or iron fitted through or over the rudder-stock. In steering with a tiller it is pushed to the *right* that the boat may turn to the left, and to the *left* when it is to turn right. Use yoke-lines or tiller with steady hands; do not hurry or jerk, but take it so that the boat may turn gradually and gracefully; taking or making sharp turns retards progress and tends to rolling. A wise use of the rudder keeps the boat's course under constant and uniform control, while it enables the oarsman to give his attention and strength to his stroke.

The "rules of the road" in rowing are as follows:—(1) A row-boat going up-stream or against tide should take the most convenient bank or shore, and should keep *inside* (*i.e.* nearer the bank than) all boats meeting it. (2) One going down-stream or with tide should take a course in mid-river or with tide, and keep *outside* (*i.e.* farther from the bank than) all boats meeting it. (3) Any row-boat overtaking another boat proceeding in the same direction should keep clear of the overtaken boat, which ought to maintain its course. (To come into contact with any boat or oar or person in it through disregard of this rule is to commit a

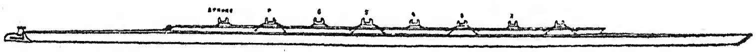
foul.) (4) One boat meeting another *end-on* (*i e.* when only her bow can be seen), if in still or open waters or lakes, should keep to the right, passing the boat met on the port (*i.e.* left) side. (5) A row-boat with a coxswain should give way to a boat without one (as a coxswain's directive responsibility for the management of his boat is special while it is



Fouling.

under way). (6) A row-boat must give way to all other craft, especially sailing boats, and go astern of them.

Boats may be either single-banked—having one rowlock to each thwart and for one rower; or double-banked—having a rowlock on each side of each thwart, and seating a rower on each side of it. There are pair-oared and four-oared boats, and some have accommodation for six, eight, and even ten—*e.g.*, the Eton eight and the Monarch ten on the 4th of June. When ten or more oars are plied the boat is often called a cutter. *Rowing randan* is using a bow and a stroke oar, with a pair of oars plying between them. The foremost man in a rowing-boat is *bow;* the aftmost is *stroke.* All the



Eight Oar Boat.

other men are addressed by number—2, 3, 4, 5, &c., according to their order at the rowlocks. The oars have figures on their looms, corresponding to the number of the oarsman and the thwarts they occupy. Bow is No. 1; but stroke is always spoken to or of by the title *stroke*, not by a number. His is the master-stroke that is to be followed by all the other rowers in time and force. Bow-side is the left, stroke-side the right. Cox or coxswain is the helmsman, the man that steers.

Stroke-oar ought to be the most skilful and able person at the oars. He is the one to whom all the others look as leader and pattern—to be followed and emulated with science and patience. In rowing stroke he sets off with and keeps up a long, steady, and well-measured pull, the oar being raised, dipped, drawn towards him with undeviating regularity, and with a blade undeepened in its course through the water. He never suddenly increases nor decreases the play of his oar while the boat travels, but maintains the same time and speed all through his stroke. Everyone rowing with him must move with equable facility and address. Do not be content with keeping time, but keep stroke also; avoid rowing with hands high and blade deep; bring the handle up to the body, not the body to the handle; hold on with unslackened arms till the stroke is full ended, and persevere in maintaining simultaneous dip, pull, and lift.

While learning to row, it is a wise plan to have the same company and partners during practice until the novice can use his legs, when firmly pressed on the stretcher, in getting him through the first half of a stroke; take an early and sure grip of the water with his oar, and make a good, full, long, strong, well-timed, and skilfully swung pull in imitation of the man on the after-thwart. Having thus secured control over strength and stretch among his accustomed fellow-oarsmen, he should change thwarts and oars with his comrades, getting in succession into neighbouring seats, say seven with stroke, five with six, three with four, and two with bow. thereafter taking the even numbers where he had taken the odd ones. While so practising let him see that he swings straight, looks right aft, avoids screwing about or jerking, and does his fair share unshirkingly. Of course it is right that as far as possible the oarsmen paired together should be much about the same weight, similar in stretch and style. Rowing in matches should not be attempted till he knows how to keep his place among his comrades, and use his oar, with purposeful resolve to avoid scratchy strokes, and to observe with reliable endeavour everything he has learned to do in the noble art of rowing and sculling.

CHAPTER XVIII.

FENCING.

The art of fencing is a difficult and delicate one. It requires a keen eye, a ready, firm, supple wrist, steady yet sensitive nerves, muscles of healthy tone under complete control, and a speed and lightness of touch which act like instinct.

Fencing brings out most effectually of all amusements and competitions the entire individuality of those who engage in it. As a part of the social equipment for self-protection it has fallen out of use in Great Britain, though not in other European countries; but as the art of personal training and development it holds the highest rank.

The following suggestions may perhaps be found of service :-

(1) Never on any account begin to use the foils without wearing the proper guards, especially the mask or face guard.

(2) Opponents should always take care to begin play out of distance.

(3) The act of crossing and touching the blades of the foils ought to be regarded as the signal that both players are ready, and no hit should be given before this preliminary.

(4) Players should settle, before they begin to cross weapons, how many hits are to be counted as constituting a game. The numbers chosen should preferably be odd and low ones—3, 5, 7, 9, &c. This, by fixing a point to be aimed at, prevents overstrain, induces attention and care—thus increasing the interest and usefulness of the exercise.

(5) No hit should be considered effective (*i.e.* be counted) which is given with any other part of the weapon than the point. Hits made on the mask do not count.

(6) Two thrusts should not be made on the same lunge.

(7) Opponents, in play, ought not both to strike at once. Should this however happen, if both have lunged, the hit is counted to neither; or if counted it should be that only which has been given in the third position.

(8) A disarm counts as a hit to the player who effects it.

The body ought to be encased in mask, double-jacket, body-pad, and gauntlets.

The *foil* is the instrument chiefly used in fencing as a pastime. It represents the *rapier* or small sword, the weapon used in hostile encounters. The foil consists of a thin elastic steel bar, the point of which is for safety's sake protected by a flat "button" covered with leather, so that when a thrust is made it cannot wound. This blade is technically spoken of as having two portions—the *forte*, one-third of the length from the hilt, and the *foible* the remaining two-thirds to the point. Such a weapon varies in length from hilt to point in proportion to the stature of the person who uses it—between 30 and 32 inches is reckoned a medium length, and the maximum seldom exceeds 36 inches. The foil is a simple mechanical lever; the *forte*, being nearest the power, has the greatest strength. Hence a thrust can be parried by pressing on the *foible* or outer extremity of an opponent's foil with the *forte* or inner

portion of your own, and thus diverting his point from its intended object.

The foil should be held lightly but firmly by the fingers and thumb, as shown in fig. 1. The thumb should be placed on the convex side of the grip, and the other fingers

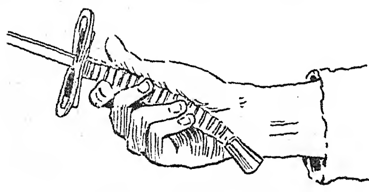


Fig. 1.—Holding the Foil.

closed on it so as to hold it in the hollow of the palm, called the "line of life." The thumb should not touch the hilt or guard of the foil. Holding the foil as described in the right hand, with finger nails up and point turned towards the ground, stand erect with the right foot pointing straight in

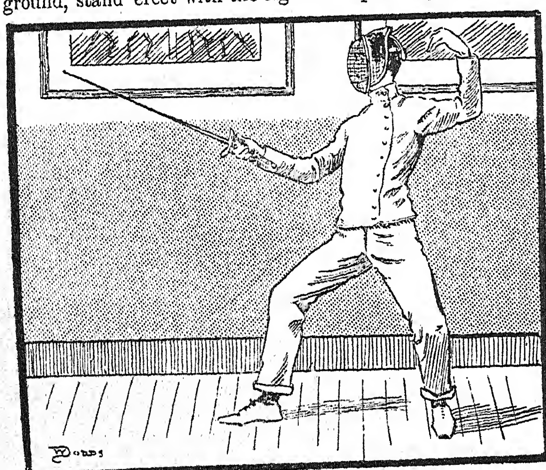


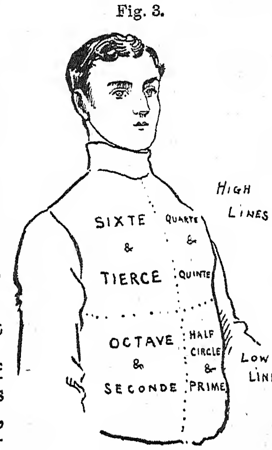
Fig. 2.—On Guard in *Quarte*

front, and left foot to the left, the heels together. The foil should then be directed towards the neck of a supposed opponent, the hand being held level with the left breast and the elbow just clear of the right hip. Then bend both knees and advance the right foot to the front about twice its own length. The left arm should be raised, being held behind the body with hand drooping forward to balance the right arm and foil (as in fig. 2). The position thus taken is designated "on guard in quarte." From this position the "advance" should be practised by moving the right foot forward a short rapid step, immediately followed by bringing up the left foot a similar distance while preserving their relative positions. The "retreat" is effected by moving back the left foot first, and following it up with the right.

To make a thrust the point of the foil must be dropped until it is somewhat lower than the hand which holds it, and the arm suddenly straightened to its full length. The "lunge" is a continuation of this movement. Holding the sword-arm perfectly straight as described, shoot forward your right foot about twice its own length, at the same moment propelling the body forward by straightening the left leg while the left arm is dropped to the side, palm outwards. These combined movements should be practised until they can be performed as one with great rapidity and the point of the foil can be brought to touch whatever spot has been decided on. The getting back to the position of guard after the lunge, called "recovery," is effected by drawing back the right foot, bending the left knee, bending the right arm and raising the left, so as to resume the position from which the lunge was made. In order to increase the distance covered by the lunge, the left foot is often brought up nearly to the right while the knees are still bent. This must be done neatly and quickly, so as not to attract an opponent's attention. In all these movements the balance of the body must be preserved, as this is essential to perfect control. When on guard the knees should be so far bent that each foot is entirely concealed by them from your own view.

Here it is necessary to explain that the surface of the fencing jacket is mapped out into four (imaginary) quarters, which are called "lines," the two upper quarters (as shown in fig. 3) being called "high lines," and the two lower "low lines." These are again divided into sides, the right being the "outside" and the left the "inside." These areas are threatened by varying forms of attack, and are protected by different "parries." Attack on the high lines and the answering parry are said to be "in sixte" if the hand is held nails upward, or "in tierce" if it is held nails downward.

Fig. 3.



In assuming the position of "on guard" it is best to cross blades with your opponent, which act is called "engagement," and it should be your endeavour, so long as you act on the defensive, never to lose touch of the adverse blade for a moment, or having lost it to find it again as promptly as possible. When so engaged, if your opponent lunges, there is no need for such a definite movement as a parry. All you require is to protect yourself by a degree of pressure against his foil proportioned to the strength of his attack, by which his point can be readily turned aside from its aim. Fencers generally form the engagement of "quarte," which specially protects the high lines of the left side of the body, leaving those on the right side to be protected when threatened by the appropriate parry. Simple parries are those in which an opponent's foil is followed into the line of attack and then warded off. The names of the simple parries are *prime*, *seconde*, *tierce*, *quarte*, *quinte*, *sixte*, *septime*, and *octave*. In England *septime* is commonly called "half circle."

The parry of *quarte* is made, from engagement of sixte,

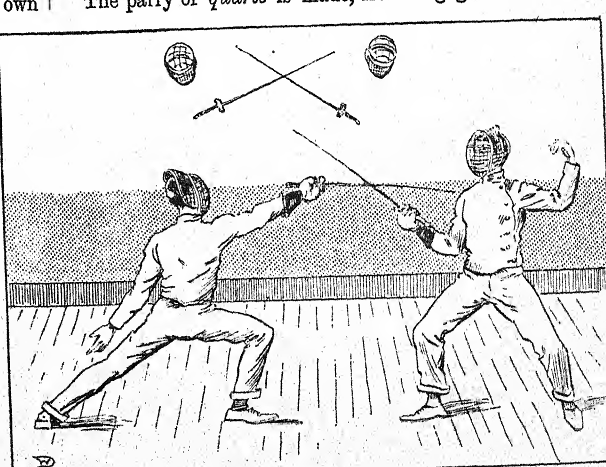


Fig. 4.—Parry of *Quarte*.

by carrying the blade smartly across the body, using the fingers and wrist rather than the arm in the movement; and by a quick tap of the forte of your foil against the foible (or weaker part) of your opponent's his point is turned away from the direction of your body. The elbow of the sword-

arm should be kept as close to the body as possible without inconvenience, nearly level with the hip bone. The hand should be held nails upward, and the point of the foil kept as nearly stationary as possible, so as to be ready for an answering thrust (see fig. 4). The parry of *septime* is used when the low lines on the left side are threatened, and is made from the engagement of *quarte* by dropping the point

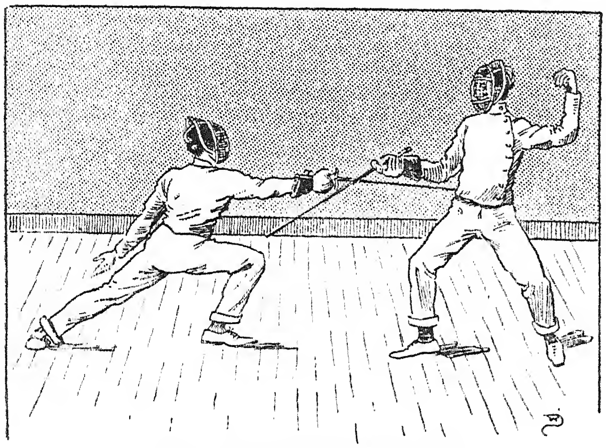


Fig. 5.—Parry of *Septime*, or Half-circle.

below the hand and moving the blade to the left with a semicircular sweep. The point, however, should not be dropped lower than the bottom of the opponent's jacket, as in fig. 5.

The parry called *high septime* is made in the same way to protect the high lines on the left side, by raising the sword-hand to the level of the chin.

The parry of *sixte* is made from the engagement of quarte by carrying the foil across the body so as to protect the right breast, as the parry of quarte protects the left. Here

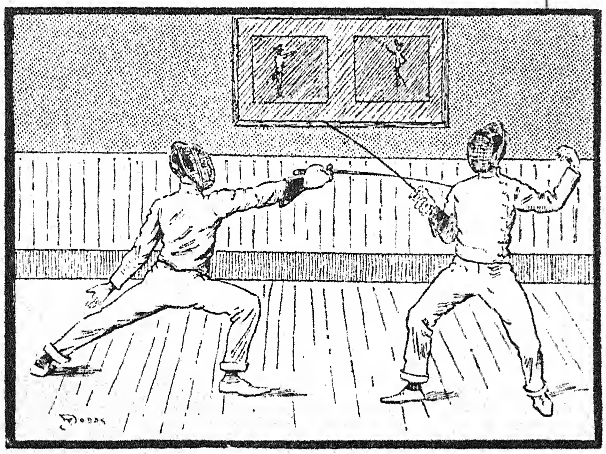


Fig. 6.—Parry of *Sixte*.

also the point of the foil should be kept nearly stationary, the move being made with the forte, and as far as possible with the wrist and fingers only, as shown in fig. 6.

If the low lines on the right side are threatened the parry of *octave* is made from the engagement of *sixte* by keeping the hand in the same position but dropping the point below the hand (fig. 7), precisely as is done from the engagement of *quarte* to *septime*, when the low lines on the left side are threatened. In all the parries above described the hand is held nails upward.

The parry of *quinte* or "low quarte" protects the middle region of the left side of the body. It is made by lowering the hand from the position of *quarte* towards the left hip and applying sufficient pressure to the left to carry the opponent's point clear of your body. Your point should be kept upward in direction though it has to be lowered in position.

The parry of *tierce* is the same as that of *sixte*, except that it is made with the finger nails downward; the parry named *seconde* differs from that of *octave* in the same respect. The parry of *prime* is also made with the back of the hand turned upwards as far as possible. From the position of guard in *quarte* the hand is moved in the direction of the left shoulder, while the point of the foil is lowered and the back of the hand turned upwards and rather to the left. This parry protects the low lines of the left side, and may be transferred to the high lines on the same side by raising the hand, when it is called *high prime*.

Though the four simple parries, *quarte*, *septime*, *sixte*, and *octave*, are in theory sufficient to resist any variety of attack, they are found in practice not to be rapid enough for certain emergencies. To meet these, *counter* or circular parries were introduced.

Quarte.—From the engagement of *quarte*, as your opponent disengages to make his thrust, you follow the movement by dipping your point under his blade and bringing it round in a circle from left to right (as shown in fig. 8), so as to bring it back to the side on which you were engaged when he commenced his move. Your hand should be kept steady in position, and only the point of the foil moved by fingers and wrist.

Sixte.—From this engagement the counter parry is made exactly as from the engagement of *quarte*, except that the circle made by the point is in the reverse direction, or from right to left.

Septime.—From this engagement, in which the blades are pointed downwards, as your opponent raises his point to disengage, raise your own and make a circle round his blade, which brings it back to the side from which it started and preserves your guard, as shown in fig. 9.

Octave.—This engagement is also on the lower lines, and the counter parry is made as in the counter of *septime*, except that the circle described by your point is in the reverse direction to that shown in fig. 9. Although other counter parries exist, these four will sufficiently illustrate the principle on which all are executed, and when sufficient dexterity has been acquired by practice of these counter parries it will be found easy to extend the principle as the need arises.

The forms of attack may be either primary—that is, initiated by the attacking party—or secondary, in retaliation for an attack which has been foiled, or made to prevent the delivery of one which has been foreseen. An attack should always be delivered with the sword-arm perfectly straight, hand held nails upwards, and the point of the foil *lower* than the hand. The impetus of the "lunge" is derived from the legs, the right foot being suddenly moved forward and the left leg straightened so as to throw the entire body forward. These movements so rapidly succeed the straightening of the sword-arm as to seem part of one move. The act of changing from one line preparatory to an attack on a different line, called disengaging, is done by passing the point of your foil under the blade of your opponent's if from one high line to another; if from a high line to a low one by dropping the point, or if from a low line to a high one, by raising it. When this forms part of an attack the arm should be straightened simultaneously with the disengage, so that the thrust may follow with the utmost rapidity to prevent its being successfully parried.

A counter-disengage is a movement similar to the disengage, but made in the reverse direction. If an opponent disengages from quarte, you lower your point and pass it round his blade by a circular movement, resuming the line of engagement and at same time straightening your arm and lunging in quarte with sufficient pressure to the left to prevent your blade being diverted from its aim. On other changes of engagement this attack is made on similar principles, only allowing for the different positions of the foils.

The attack called "cut-over" is executed by drawing back the foil, bending the arm so as to raise the point, and then throwing it over your opponent's blade while you straighten your arm and lunge. The change in direction of the point should be made by the fingers, the hand should be kept nails upwards, and should be higher than the point when the lunge is made. In order to be successful this mode of attack requires great rapidity and dexterity of movement.

A feint is a pretended attack intended to distract an adversary's attention and so mislead him as to put him off his guard, and gain the advantage of making the attack in a different line. This is done by making a motion towards a certain *line* just at the moment the right foot is raised from the second position. By this manœuvre, if rightly managed, the opponent's blade is put into an awkward position for so recovering as to meet the real attack, which when made should be done with quick precision and a straight arm. Every movement made in fencing should have a purpose. Practice alone can secure the speed of eye to detect and countervail a feint, and strength of judgment to resist the decoying suggestion of one unless the entrance to the likeliest real attack be well covered.

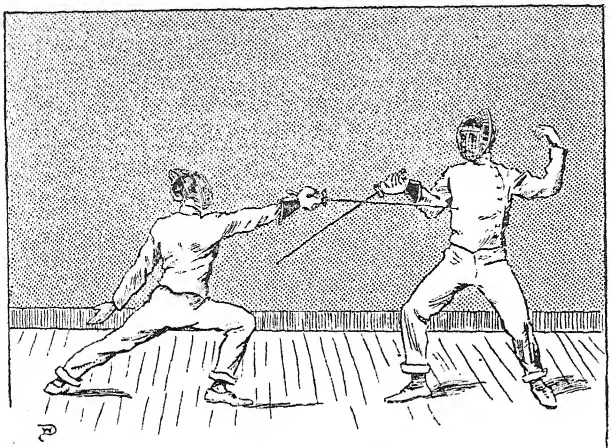


Fig. 7.—Parry of *Octave.*

All feint attacks depend for their development on the reception they meet with. If, being engaged in one line, on your threat of attack in another, your opponent does not take the trouble to move his hand to parry, you should, if you are near enough, turn your feint into a reality by lunging in. If he parries, you must be guided by the parry he selects as to the further conduct of the attack, trying to get round or under it, as the case may admit.

Another mode of attack consists in trying to force your opponent's blade from its position, to give you an opening to lunge. This is sometimes done by a short quick tap of your forte on his foible, necessitating the withdrawal of your blade a little way from contact, which has its risks. Or an opponent's blade may be pushed out of line by varying degrees of pressure of your forte on his foible, the pressure being supplied by fingers and wrist. Sometimes a thrust can be made almost in the line of an opponent's blade with just sufficient pressure to force his blade out of line.

Fig. 8.

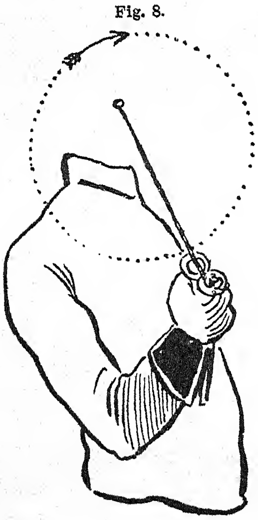
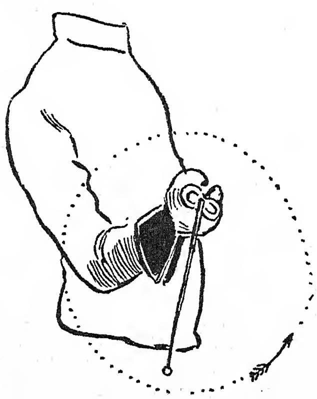


Fig. 9.



The attack called a *riposte* is a thrust made in return for an attack which has been successfully parried. A *riposte* may be made either (1) direct from the parry without pause to allow your opponent to recover from this extended position on the lunge ; (2) changing the line by a disengage or cut-over. The *riposte* is usually made from the position of the parry to save time, except that when the parry is made with the hand nails downward the position is changed and the thrust made nails upward. In disengaging from one of the high line parries it is often found best to drop the point into one of the low lines and make the attack there, with the view of disconcerting your opponent in his parry. A *counter riposte* or *remise* is an attack made after parrying a *riposte* by the fencer making the original attack. Sometimes an attack is made with the express purpose of leading up to a *counter riposte*, but this form of attack has no chance of success unless you are a really expert fencer. Unless the lunge has been made in the best style and with full control of every movement, it will be difficult to meet the *riposte* with a neat and rapid parry so as to give an opportunity for a *counter riposte.*

We have now supplied the would-be fencer with the meaning of the main terms used in the elementary processes of this variety of the art of defence, and defined for his use the most necessary evolutions. Innumerable combinations of these become possible in the hands of experts ; but these are developments which are only to be understood and practised by those who have learned the rudiments in some such form as we have now presented them.

THE END.

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